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RESEARCH TRIANGLE INSTITUTE

RTI Project OU-230-2 January 1968

AD828903

Operations Research and Economics Division

OCD Work Unit 4113E

DETROIT CIVIL DEFENSE OPERATING SYSTEM SYNTHESIS

VOLUME II
TECHNICAL APPROACH

by

Robert N. Hendry

Prepared For

Office of Civil Defense
United States Department of the Army
Contract No. OCD-PS-64-56

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RESEARCH TRIANGLE PARK, NORTH CAROLINA 27709

PRELIMINARY REPORT
OU-230-2

DETROIT CIVIL DEFENSE OPERATING SYSTEM SYNTHESIS

Volume II

Technical Approach

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January 1968

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FOREWORD

The description and approach covering the synthesis of one or more total near-future civil defense systems was performed under the Office of Civil Defense Contract No. OCD-PS-64-56, Modification No. 15 dated 1 May 1967. Initially, work was assigned to Work Unit 4113E. This number has been changed to 4126A for the continuing effort.

Volume I offers a preliminary description of a total civil defense system at the local level. Detroit's CD system was selected as a specific case for study. It is intended that subsequent research will improve this initial description and provide a basis for describing competing system concepts. If system alternatives can be described in a manner comparable to the Detroit study, quantitative systems analysis can be expected to yield performance criteria that will make selection of the most effective alternative possible.

Volume II describes the technical approach to the system synthesis and indicates that it will be suited to the Five-City Study. Subsequent work will continue to develop this approach as a means for unifying research effort to achieve civil defense objectives.

The author expresses his indebtedness to Mr. Charles Kepple of the Research Directorate of the Office of Civil Defense for assistance in providing materials, arranging briefings and conferences, and in reviewing and making recommendations as the study progressed. The author also expresses his appreciation to Mr. Philip McMullan, Group Leader, and to others in the Research Triangle Institute who provided guidance and support during this system study.

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DETROIT CIVIL DEFENSE OPERATING SYSTEM SYNTHESIS

Volume II

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DETACHABLE SUMMARY

The Research Triangle Institute was given the task of synthesizing a local civil defense system. Volume I describes the system as it may be expected to exist in an emergency. Volume II describes the technical approach to systems synthesis.

The Detroit Civil Defense Operating System is an example of a local system synthesized as a basis for a systems analysis. A diagrammatic description, adopted in support of a narrative description to show the system's functional and physical aspects, can be referred to in greater levels of detail as more information is developed.

The principal sources of information were the civil defense plans developed by Mr. P. C. McGillivray, Director of the Detroit Office of Civil Defense. These plans were used together with other data both printed and verbal as the basis for the system description.

The primary tasks in developing the diagrams were to identify and classify the controls, functions, and components and to interrelate them to show the operation of the total system. First, the elements were identified and classified by time phases within the emergency period. Second, functions and components were reassembled into a time-phased set of operations to solve civil defense problems occurring in small areas of the city.

The system description takes the form of: (1) a set of time-phased functional flow block diagrams representing functions needed to minimize or solve defined problems, (2) a resource organization assignment matrix needed to assign functions to the various system components, and (3) a schematic block diagram showing the utilization of resources needed to solve the problems occurring in the individual operating areas. The system diagram developed during the study shows all three forms of the description and represents a basic civil defense operating subsystem. The total system should be visualized as many basic subsystems operating simultaneously.

In conclusion, a beginning has been made toward a description useful for systems analysis; functions, controls, and components have been interrelated to describe the Detroit Civil Defense System and how it operates. The functional flow and schematic block diagrams offer a concise description of civil defense operations, but these diagrams need to be expanded beyond the level of detail described in the report.

Research is recommended to establish a land-use classification system as a basis for a system-oriented problem definition. Studies in system synthesis should continue in greater detail and be supported by objective selection and systems analysis studies to insure that an appropriate interface exists between problem definition and system analysis.

Thus, further studies can be expected to expend this beginning into a comprehensive description which can be useful in systems analysis within the Five-City Study and, subsequently, within the Damage-Limiting Studies. Ultimately, system studies can be expected to maximize the probability of survival of civil defense resources and to minimize the effects of nuclear weapon attacks on population and property.

Detroit Civil Defense Operating System Synthesis

VOLUME II TECHNICAL APPROACH

I. INTRODUCTION

A. General

The Research Triangle Institute (RTI) was given the task of synthesizing a local civil defense system. Within the Five-City Study, the city of Detroit system was selected by the Office of Civil Defense (OCD) as the one for study. Posture and objective-selection constraints on the system description were imposed by OCD. Figure 1, Modified Five-City Study Plan was prepared showing the system synthesis task and its relationship to the other study tasks.

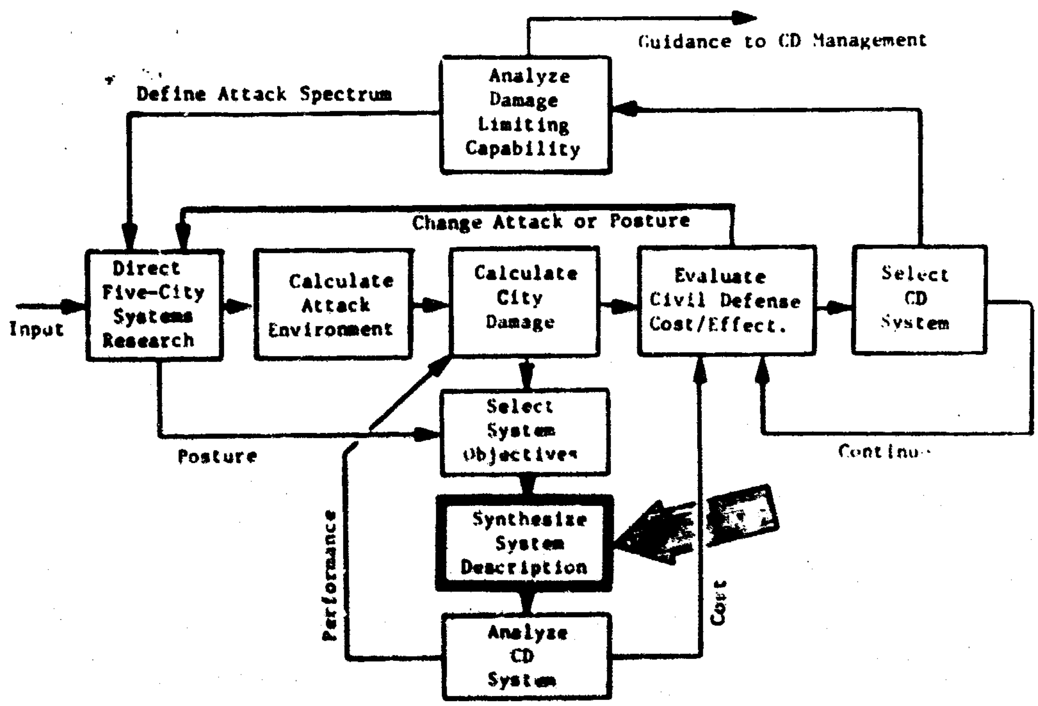

Fig. 1. Modified Five-City Study Plan.

The primary objective for the synthesis of the Detroit CD system is the i ti- fication, classification, and description of the entire system and how it oper under emergency conditions. This description does not include quantitative me res. Due to the short duration of the study, RTI has attempted only a simplified de i- tion of the system.

The output of this study will be used in subsequent systems analysis to c re quantitatively through damage calculation and cost estimation various civil de alternatives. Continuing studies are expected to expand the description in de to select objectives, and to quantify functional and physical interactions.

The description techniques discussed later in this section were adopted t present Detroit's civil defense plans. The plans were analyzed to identify and classi emergency time phases; operating areas by land use; area problem as a function weapon effects and distance to ground zero; functions and controls to solve th problems; and finally, components of the CD system. After analyzing the total roit system in terms of these elements, countermeasure (CM) operations were synthes d, resources were allocated, and functions were assigned to the component organiz on; then the operating subsystems in time and space were developed for one Standar cation Area (SLA). The total system was described as the sum of all these operating stems in Detroit.

B. Scope

The contract language under this subtask of OCD Work Unit 4113E[1/] states:

"Using the definitions, procedures, and Systems Analysis Matrix defined i 'Civil Defense Research Analysis,' J. Devaney, December 1966, synthesize one o ore near-future CD systems."

The study was confined to Detroit and local near-future systems. These s tems are total CD systems which can be synthesized (compiled or invented) within th n- straints of near-neighbors to present policy.

Control over the process of synthesis was accomplished by describing the roit system in the framework of the Civil Defense Systems Analysis Matrix[2/] and by cking all interactions in the context of row and column definitions[3/]. Although a terms have been changed by OCD since 1963 (e.g., evacuation is no longer used) and c rs need more detailed definitions, RTI used Systems Analysis in Civil Defense[4/].

1/ Contract No. OCD-PS-64-56, Modification No. 15.

2/ J. F. Devaney. Civil Defense Research Analysis, Research Report No. 11. earch Directorate, Office of Civil Defense, December 15, 1966.

3/ J. F. Devaney. Systems Analysis in Civil Defense, Parts I and II. Resea Directorate, Office of Civil Defense, August 1963.

4/ Ibid.

dictionary as frequently as possible. The terminology sometimes differs from that used in planning documents for Detroit; where this occurred, Detroit names were changed to fit the Devaney matrix definition.

The detailed study plan that RTI submitted to OCD is attached as appendix A. The planning phase was necessary to develop the approach to problem definition, objective selection, and detailed procedures that were employed in gathering data, synthesizing the system, and controlling the process. Figure 2 illustrates the general plan.

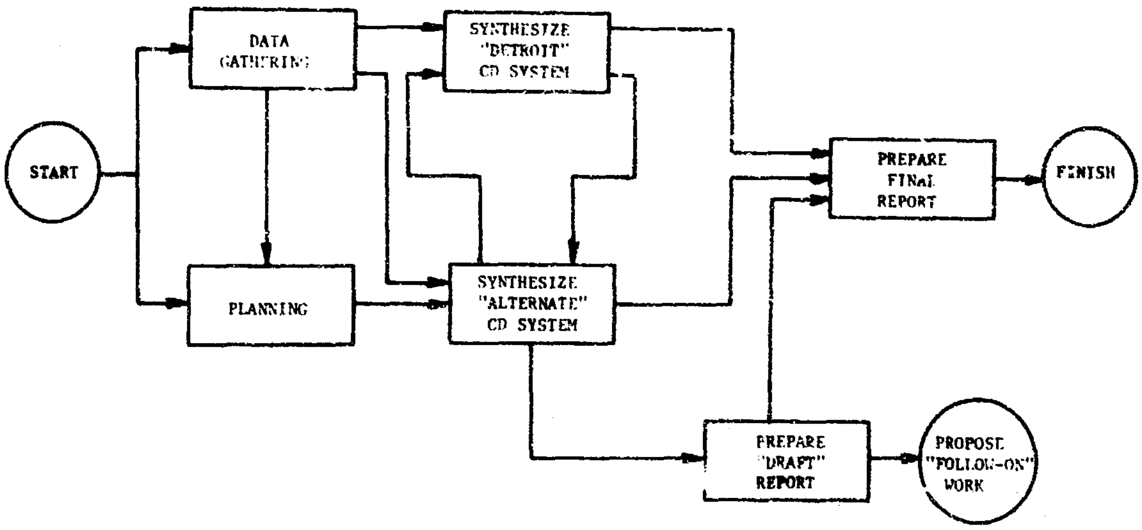

Fig. 2. System Synthesis Study Plan.

The planning and data gathering subtasks were initiated concurrently. Using available data, the plan was tested by synthesizing a preliminary alternate CD system. After this synthesis, a trip was made to Detroit to complete the data gathering phase. The Detroit system was synthesized by revising the preliminary alternate CD system to incorporate the detailed aspects. This report constitutes the product of the last subtask.

RTI's objective has been to complete a broad, rather than a deep, description of the total CD system. All eighteen civil defense functions have been included. Proposed follow-on work has been presented to OCD for consideration.

C. Detroit Civil Defense Data

A data gathering program was started early in the study and will continue in subsequent studies. Appendix D contains a bibliography of data used in this study; this list will continue to be updated as the study progresses.

The principal source of data regarding the Detroit CD system was the civil defense plans developed by Mr. F. C. McGillivray, Director of the Detroit Office of Civil Defense. These plans, together with other information both printed and verbal, have been the basis for the system description contained herein.

The overall master plan is complete; however, many of the more detailed plans are incomplete. Where formal plans have not been prepared, the description was based on discussions with Mr. McGillivray. For example, the master plan indicates that a Warden Service is contemplated; yet, no definitive plan has been formulated. No statement of warden responsibilities or assignment of the planning task had been made to another city department. As another example, the Welfare Department of the city of Detroit merged with the county and later became an agency of the state. The Detroit Office of Civil Defense had no apparent arrangement with either the state or another city department for a plan that would define the operations of the Welfare Service. Similar examples can be cited to illustrate the fact that Mr. McGillivray has had considerable difficulty in preparing his total detailed civil defense plan. His accomplishments have been admirable in view of these difficulties.

D. The Synthesis Technique

John F. Devaney's approach to systems analysis has been studied and applied to the Detroit CD system synthesis task. This study revealed that the matrix is a device for control of system studies and not a complete technique for system synthesis. The matrix and Devaney's systems analysis definitions directed the organization and reporting of interactions between integrators, inputs, and constraints. Shapero[5/] provides additional information about use of this type of matrix in systems research.

The technique adopted by RTI to define the system is based on the "black box" concept and uses the functional flow and schematic block diagrams to concisely represent the system. This approach may be summarized in the following way.

The system synthesis may be represented by figures, models, diagrams, words, or pictures which are intended to convey a mental image (real or imaginary) of a group of related things functioning together under some kind of control to protect people and to overcome the effects of nuclear weapon detonations. Thus, the first task of

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5/ A. Shapero and C. Bates, Jr., A Method for Performing Human Engineering Analysis of Weapons Systems, WADC Technical Report 59-784, Wright-Patterson Air Force Base, September 1959.

the analyst is to identify and classify the individual civil defense functions and controls in the emergency situation with particular attention to protecting people and overcoming weapon effects. These include all actions directed toward reducing damage before the weapon detonation as well as those after the burst to alleviate conditions resulting from it.

The functional flow block diagram (FFBD) uses rectangular blocks to synthesize a set of functions occurring in a parallel, series, series-parallel, and/or iterative manner. The FFBD allows the analyst to identify the appropriate operation needed to solve a problem without becoming entangled in physical detail. After the operation is synthesized, the individual functions are assigned to an organization which is mobilized from available resources. At this point, physical displacement must be considered to assure that the functions can be achieved with the available organization. A schematic block diagram (SBD) uses boxes representing components linked by lines of communication or transportation to depict the spatial characteristics of the organization. These two diagrams (FFBD and SBD) together with a resource organization assignment matrix (ROAM), which details the components, describe the basic operating subsystem with respect to a small area of the city. Summation of all operating subsystems describes the total civil defense system of the city during a particular time phase of an emergency.

The detailed approach discussed in Section II translates the CD data into a picture of the total dynamic CD system for Detroit to prepare the reader for the subsystem description in Section III.

II. DETAILED APPROACH

A. General

System synthesis was achieved by the following procedure. First, data were analyzed to identify and classify the various civil defense functions, controls, and components by time-phase, operating area, and problem definitions. Next, functions and controls and the components performing them were reassembled into an organized time-phased set of operations to solve CD problems occurring in small areas of the city. For this study a small area of the city is defined as the standard location area (SLA).

The system synthesis takes the form of:

1) A set of time-phased functional flow block diagrams (FFBD) representing functions needed to minimize or solve the defined SLA problem.

2) A resource organization assignment matrix (ROAM) assigning functions and allocating resources to components of the organization.

3) A schematic block diagram (SBD) showing the deployment of components with respect to the SLA and the transportation and communication links between them.

Although calculation of damage is not specifically a part of system synthesis, the assembled system must relate to these calculations; otherwise, assessment of system effectiveness (which is one of the main reasons for system synthesis) is not possible. During the preattack phase, operations are directed toward decreasing the vulnerability of SLA's to weapons effects; this is expressed in calculations of people and property damage by changes in applicable vulnerability indices. In the post-attack phase, operations are directed toward solving problems created by weapon effects on individual SLA's.

B. Time-Phase Definitions

Considerable complexities were overcome by dividing time into discrete periods separated by recognized events; this was especially true for civil defense functions. Figure 3, Emergency Time Phases, illustrates the various time-phase definitions used in civil defense documents; the five phases selected for use in this study are: strategic, tactical, attack, survival, and recovery.

The strategic phase commences with a covert warning to local authorities from the national level following some event, whether national or international, to indicate the need for civil defense action consistent with rising tensions. The public may or may not be informed through the news media of practical civil defense measures. No emergency situation is declared, and no cessation of normal activities is expected.

An event or series of events which indicates the imminence of attack introduces the tactical phase. A national warning is followed by a local public warning. People are informed through the Emergency Broadcast System (EBS) of civil defense action. Normal activity ceases. All civil defense measures are taken to improve survivability of the community.

The attack phase starts when warning is received that an actual attack has been observed; the people are informed by a warbled siren to go to shelter.

When the attack is over and no more threat is observed, an "all clear" is announced by radio and the survival phase begins. The survival phase continues in operating areas where hazards exist.

Finally, the recovery phase begins with a "hazard all clear" and continues until a state of normalcy is achieved.

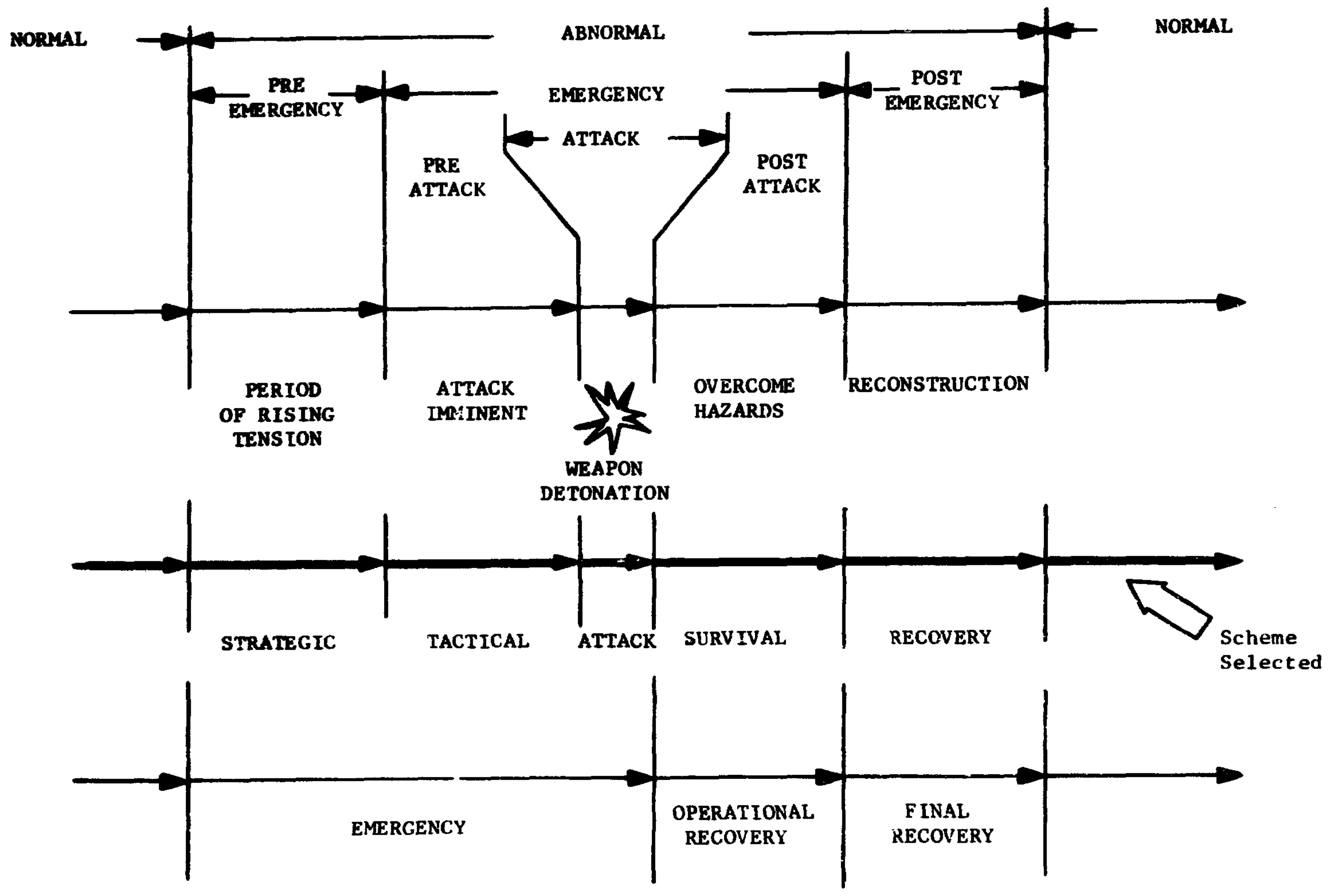


Fig. 3. Emergency Time Phases.

The five time phases selected do not necessarily coincide with Detroit or those in the Federal CD Guide terminology; rather, they are a compromise fitted to the system synthesis problem.

C. Operating Area Classifications

During various time phases -- particularly, the attack and survival phases - areas within Detroit have different problems. Small land areas were defined in order to recognize these differences. SLA was chosen because data is available on area, building type, population, and shelter. Postal zones, zoning ordinance districts, telephone exchange districts, wards or other political or service areas could have been used; however, the SLA seems to be the most satisfactory operating area definition at this time.

Each SLA (or census tract) was studied and divided into classes having similar land-use characteristics, as determined by existing zoning data[6/]. Five first-level classes, representing 15 second-level classes and 33 third-level classes, were obtained by grouping areas with similar characteristics.

Figure 4, Detroit Land-Use Classification, shows Detroit at the first level of SLA definition. Table 1, SLA Classification, lists the SLA classes together with their land-use codes. The land-use codes were selected and grouped to correlate Dikewood[7/] building type with land use and to establish the feasibility of this approach to a definition of operating areas. Preliminary investigations of zoning data suggest that SLA's should be classed by the relative distribution of land-use types. Previous work has already related land-use types to building types. Appendix B includes SLA classification to the fourth level of detail. Figure 5, Detroit SLA Population Density, and Figure 6, Detroit SLA Building Density, show the relative distribution of city activity. Thus, land use, building type and density, population density, and highway and utility networks should be considered in deriving a proper operating area classification.

A more detailed study is needed to define adequately the response of typical operating areas to weapon effects. Classification must be determined by responses to weapon effects. These responses represent civil defense problems. Once defined, these problems, in turn, define to a large extent (as shown by Figure 7, Problem Definition and Countermeasures Relationship) the functions which the Detroit CD system must provide to achieve its objectives.

6/ Official Zoning Ordinance of the City of Detroit. 1 February 1963.

7/ L. W. Davis, F. J. Wall, D. L. Dummers, Development of "Typical" Urban Areas and Associated Casualty Curves, Albuquerque, New Mexico: The Dikewood Corporation, April 1965.

Fig. 4. Detroit Land-Use Classification.

Table I

SLA CLASSIFICATION

SLA Type	Open	R1	R2	RM	B	BH	M	Typical Ct. No.	Est.Ave. Density
			LAND-USE CATEGORIES*						
RURAL	50-100								3000
I-1	75-100	0-25			0-25		0-25	354A	1584
II-2	50-75	0-25			0-25		0-25	666A	5050
II-3	50-75	25-50			0-25			353B	4430
SUBURBAN RESIDENTIAL		50-100							8000
III-4	25-50	50-75		0-25	0-25	0-25		454	4668
IV-5	0-25	75-100						351B	11118
IV-6		75-100	0-25					76	13130
IV-7		75-100			0-25	0-25		410B	5997
IV-8		75-100	0-25	0-25	0-25	0-25	0-25	204B	8105
IV-9		75-100			0-25	0-25	0-25	662	15694
IV-10		75-100	0-25		0-25		0-25	204A	8522
V-11		50-75	0-25		0-25	0-25		156	18223
V-12		50-75	0-25	0-25	0-25		0-25	355B	10543
URBAN RESIDENTIAL			50-100	0-50					18000
VI-13		50-75			0-25		25-50	604	11696
VI-14		25-50			0-25		25-50	561	13894
VI-15		25-50	0-25	0-25	0-25		25-50	661	4928
VII-16		50-75	25-50	0-25				185	19675
VII-17		25-50	25-50	0-25	0-25	0-25		161	20143
VIII-18			75-100		0-25	0-25		68	20053
VIII-19			75-100	0-25	0-25	0-25		523	22077
VIII-20			75-100		0-25	0-25	0-25	73	15288
IX-21			50-75	0-25	0-25	0-25		176D	26303
IX-22			50-75	0-25	0-25		0-25	11	21480
IX-23			50-75		0-25	0-25	0-25	115	20846
X-24			50-75	25-50				511	12431
XI-25			50-75		0-25	0-25	25-50	106	10953
XI-26			50-75				25-50	12	26321
XI-27		0-25	25-50	0-25	0-25	0-25	25-50	42	12270
XII-28			25-50	25-50	0-25	25-50		25	9470
XII-29			0-25	25-50	0-25	25-50		34	19111
XII-30	0-25			75-100	0-25	0-25	0-25	28	51252
XII-31		0-25	0-25	50-75	0-25	0-25	0-25	153	32887
COMMERCIAL						50-100			13000
XIII-32			0-25	0-25	0-50	50-100		31	25402
INDUSTRIAL							25-100		5500
XIV-33		25-50			0-25		50-75	402A	3485
XIV-34			25-50	0-25		0-25	50-75	503	10522
XV-35		0-25	0-25	0-25	0-25	0-25	75-100	3	5862

* Source: Official Zoning Ordinance of the City of Detroit as amended to Feb. 1, 1963.

Definition of land-use categories:		Zoning Codes Used:
Open	- Areas without significant buildings	P1 - other
R1	- Single family dwelling	R1
R2	- Two family dwelling	R2
RM	- Multifamily dwelling	RM, RMA, RM4, RMV
B	- Light business	B1, B1A, B2
BH	- Heavy business	B6, BL, BC, PC, PCA, C6
M	- Manufacturing	M[illegible], ML6, MH

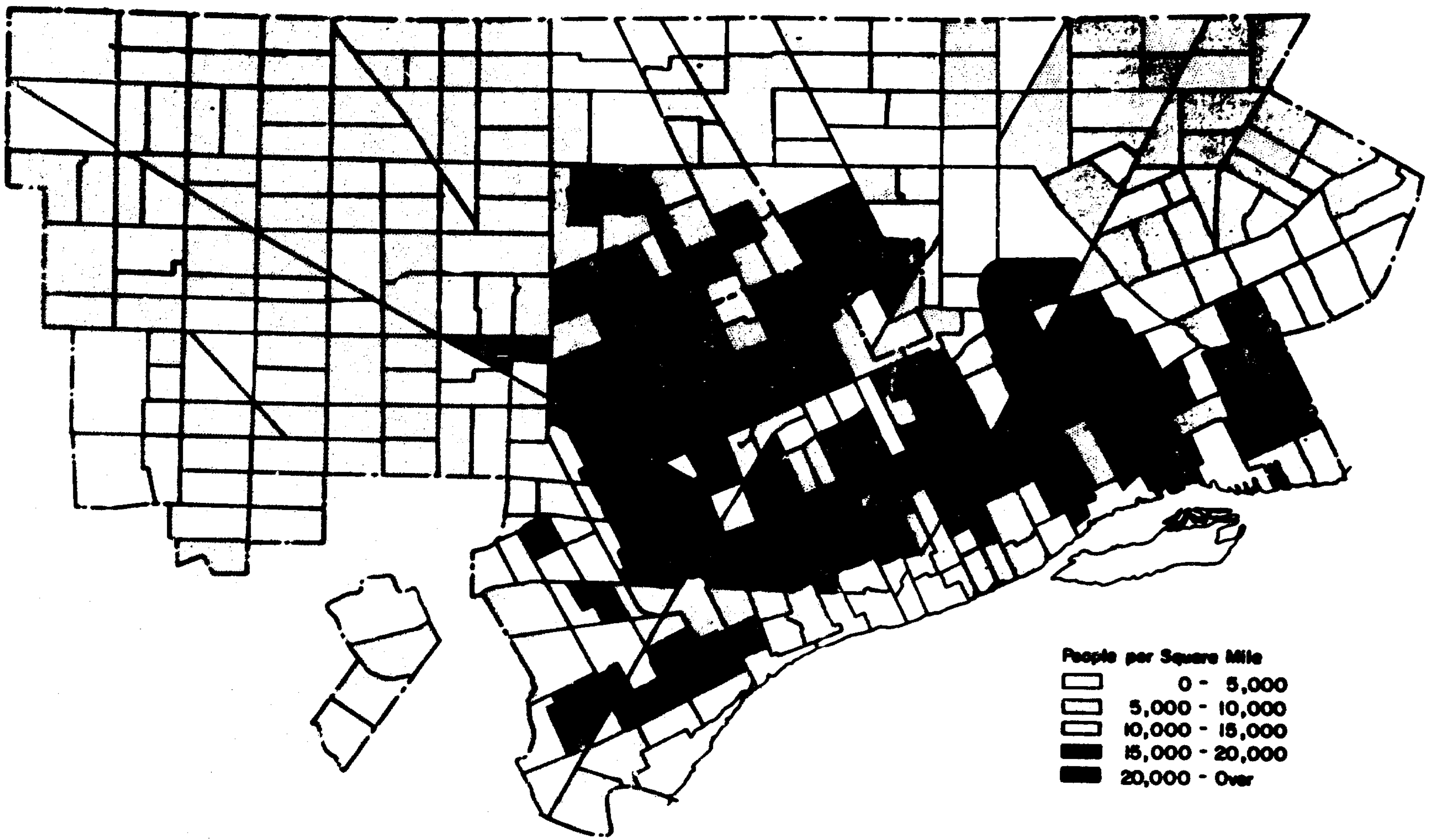


Fig. 5. Detroit SLA Population Density.

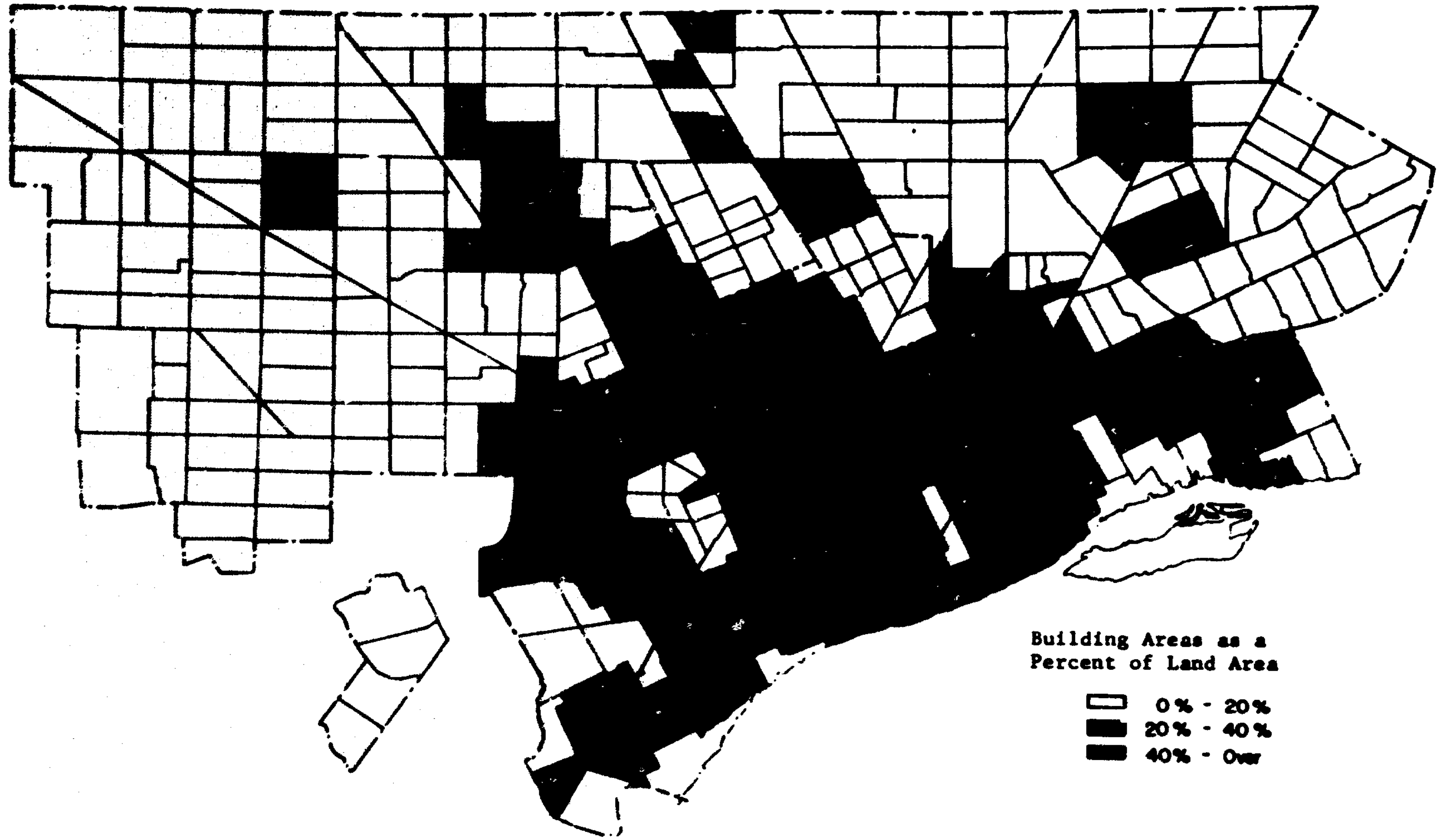


Fig. 6. Detroit SLA Building Density.

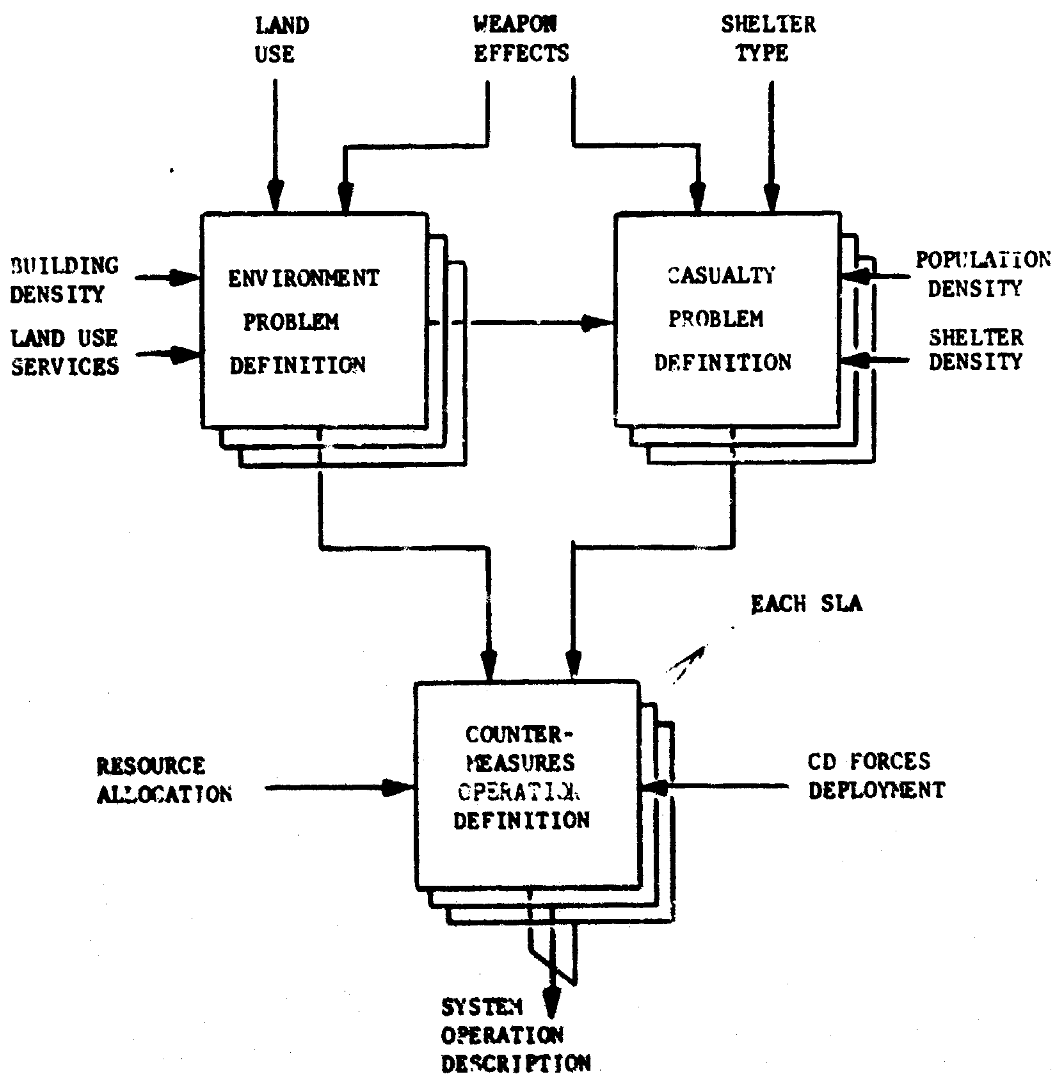


Fig. 7. Problem Definition and Countermeasures Relationship.

D. Area Problem Definition

In other problem definitions, cities were defined as areal distributions of people; however, for detailed damage calculations SLA's are more suitable to damage measurement and countermeasure solution. Thus, the postattack assessment of city damage is based on SLA's which have been distributed into one of the classes which exhibit similar responses.

The operating areas must be small enough to identify problem differences, and yet, large enough to permit manageability; however, classification of types by similarity of response must not obscure significant problem differences. Criteria of significance are difficult to define. Nevertheless, certain criteria (calculation of people and property damage stems directly from an understanding of these criteria) have been selected on which to base problem definitions: casualty assessment, operating problems, and damage severity.

Figure 8, Problem Definition and Countermeasures Development Method, evolves from Figure 7 and illustrates the relationship between operating area, land-use, weapon effects, and civil defense system actions. The basic operating situations in the figure determine the countermeasures operation to be undertaken, while the casualty assessment determines the priority of these actions.

Table II, Typical SLA Responses to Weapon Effects, describes the weapon effects blast damage (B), debris level (D), and fire damage (F) --at three severity levels for the five classes of SLA's at various distances from ground zero. If all SLA's are classified and located with respect to ground zero, a summation of the class-vs.-distance matrix represents the total damage problem. Appendix C contains a cursory analysis of several "typical" SLA responses to weapon effects.

Radiation from fallout is independent of land use. Nevertheless, if the problem of radiation is added to the fire and debris problem, a potential of 27 problem combinations are defined as shown in Table III, Environmental Problem Definition Matrix . Although theoretically possible, some of the combinations are not likely to occur.

Detroit is depicted in Figure 9, Detroit Environmental Problem Definition, as a set of problems defined by the method shown in Figure 8. Thus, the classification of all SLA environmental problems (either fire, debris, or radiation) requires that the CD system assign a set of functions to counteract the problem. These functions can be readily defined as the presence or absence of such countermeasures as sheltering, firefighting, debris removal, or decontamination.

Casualty functions are used to relate the people-damage to structure-damage. Figure 10, Detroit Sheltered Population Density, represents data used in determining people-damage; Figure 11, Detroit Casualty Problem Definition, shows injured survivors

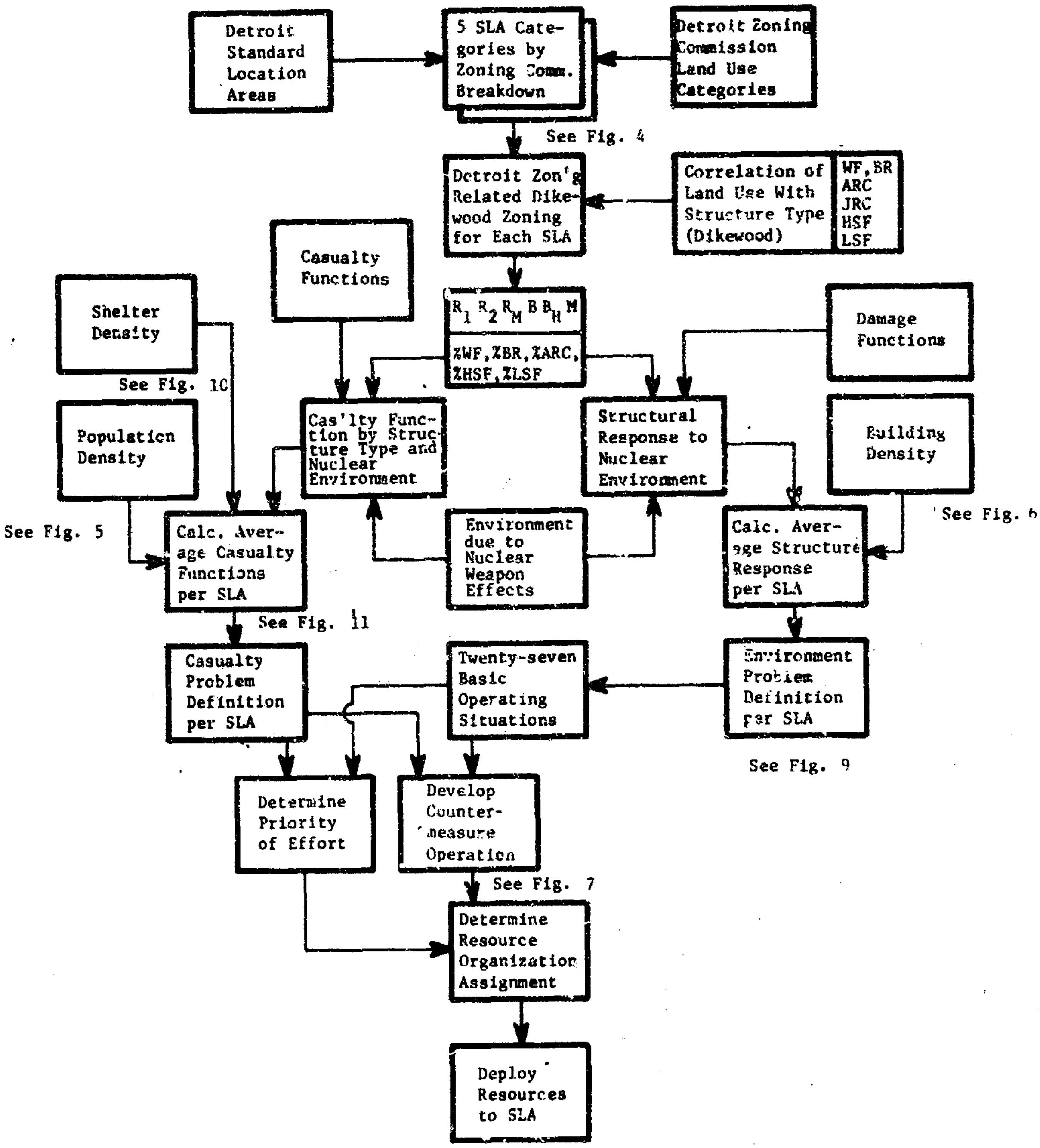
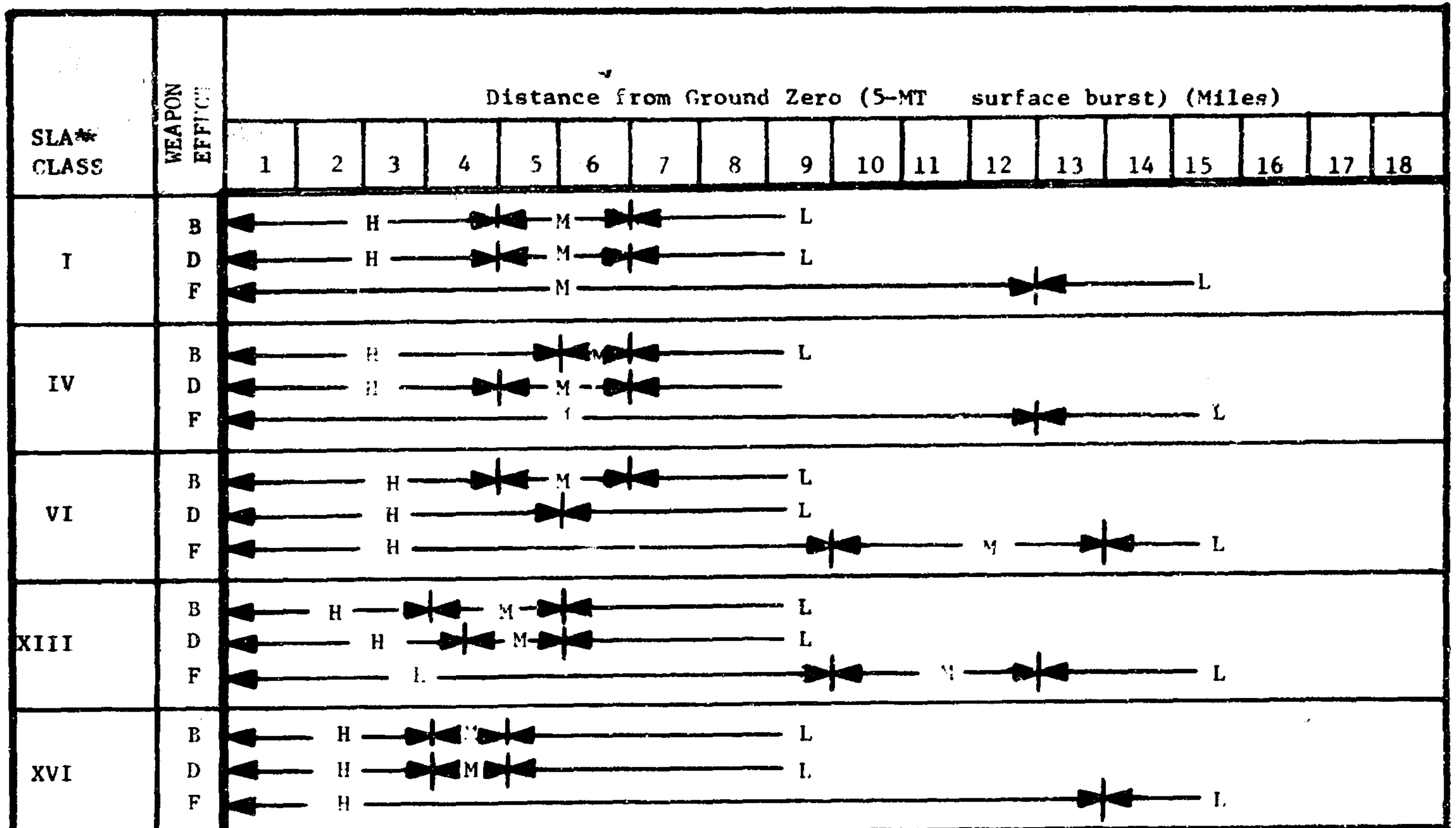


Fig. 8. Problem Definition and Countermeasures Development Method.

Table II

TYPICAL SLA RESPONSES TO WEAPON EFFECTS *



* Fallout not included; it is independent of SLA type.

** See Table I

*** Weapon Effect Severity:	Blast (B)	Debris (D)	Fire (F)
	H - >.5	H - >12"	H - >.25
	M - .2-.5	M - 6-12"	M - .10-.25
	L - <.2	L - <6"	L - <.10

Table III

ENVIRONMENTAL PROBLEM DEFINITION MATRIX *

	NEGLIGIBLE FIRE			MODERATE FIRE			SEVERE FIRE		
	DEBRIS			DEBRIS			DEBRIS		
	Neg.	Mod.	Sev.	Neg.	Mod.	Sev.	Neg.	Mod.	Sev.
NEGLIGIBLE FALLOUT	1 A	B	C	4 A	B	C	7 A	B	C
MODERATE FALLOUT	2 A	B	C	5 A	B	C	8 A	B	C
SEVERE FALLOUT	3 A	B	C	6 A	B	C	9 A	B	C

* SOURCE: Command and Control Implications of the Concept of Operations Under Nuclear Attack, 2611C, System Development Corporation, TM-L-2595/013/00, June 1967 (In Publication).

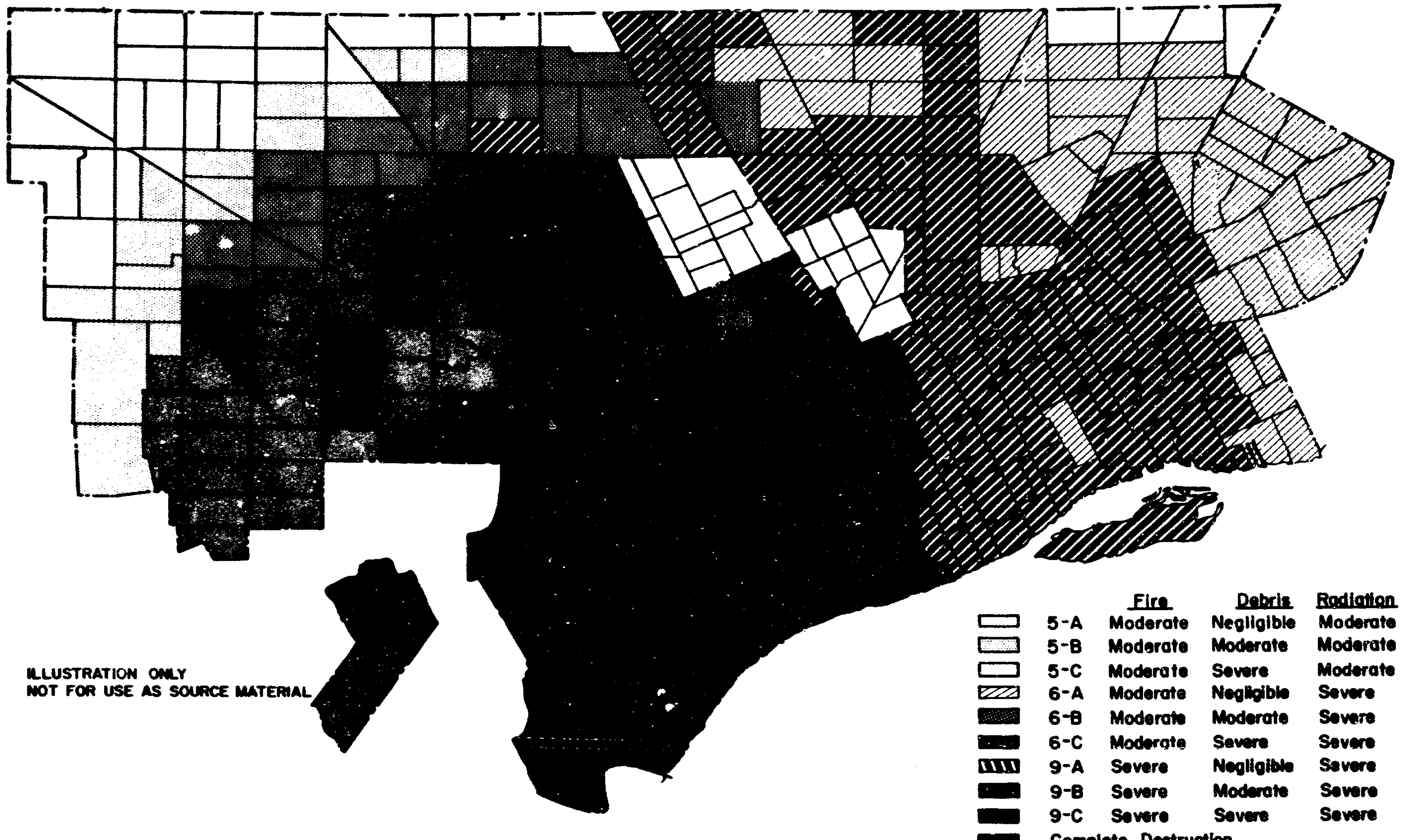


Fig. 9. Detroit Environmental Problem Definition.

Fig. 10. Detroit Sheltered Population Density.

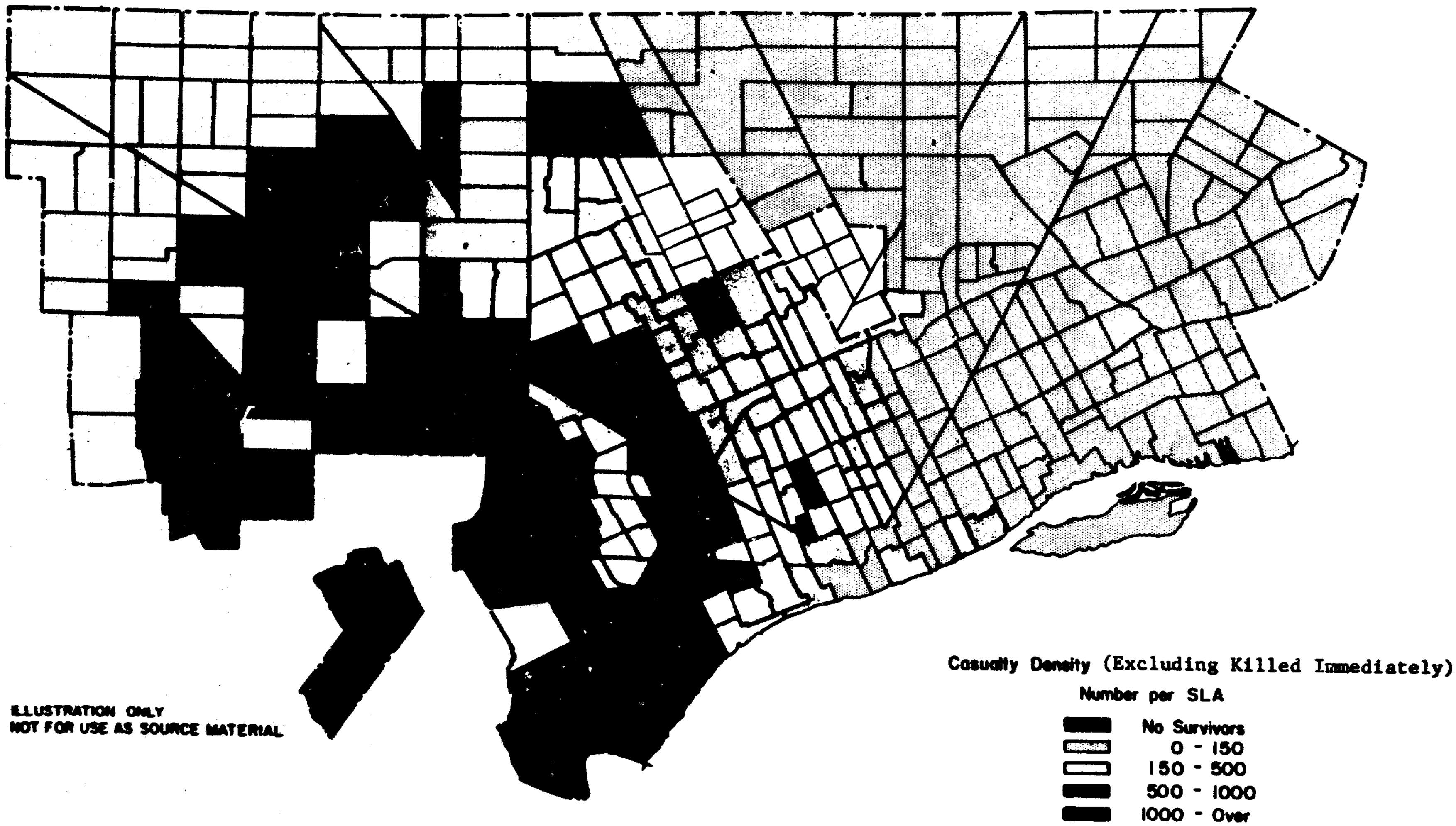


Fig. 11. Detroit Casualty Problem Definition (Prompt Effects Only).

or potential casualties derived by methods similar to those developed in OCD Work Unit Number 2511B[8/] used in conjunction with the Analytical Nuclear Casualty Estimation Technique (ANCET) computer model[9/]. A definition of casualties when applied to the operating area problem definition enables the addition of rescue, medical, welfare, and/or other functions.

A review of civil defense research documents was undertaken to establish continuity between problem definition, objective selection, and system synthesis. It is essential that the system description be linked qualitatively in system synthesis and quantitatively in systems analysis to problem definition. Otherwise, the description does not provide a useful approach to system evaluation in calculating the impact of civil defense in alleviating city damage. The problem definition illustrations are only approximations to indicate their relation to system synthesis and should not be used as source material.

Incorporation of the utility and highway networks into the description has not been accomplished at this time. A cursory analysis of potential utility damage indicates that a set of overlays may be derived which modify the SLA environment definitions in a manner similar to the radiation hazard overlay. Restoration of the networks is dependent not only on SLA damage but on damage to adjacent areas as well. Further study is necessary to determine the efficacy of this approach.

An adequate definition of the problem is needed to establish the required countermeasures and to determine the components, organization, resources, and operations of the CD system.

E. Function and Control Specifications

The Detroit civil defense functional responsibilities were identified and classified from the various available plans and were assembled into flow diagrams representing operational services. Four main functional subsystems were discernible: control, shelter, extra-shelter, or mobile and support. Only the shelter and extra-shelter subsystems act on people or property to overcome problems created by the detonation of one or more nuclear weapons. The control and support subsystems do not protect people or alleviate problems; they do enable the shelter and extra-shelter functions to perform services.

By definition, functions which are not under control are not considered part of the CD system; therefore, as a completeness criterion, all functions may be classified into one of the four subsystems.

8/ "Supplemental Analysis - Civil Defense Rescue." Menlo Park, California: Stanford Research Institute, August 1965.

9/ Alvin M. Cruze and P. S. McMullan, Extension of the General Sensitivity Analysis, Volume I, Methodology, Research Triangle Park, N. C.: Research Triangle Institute, 15 March 1967.

Since a generalized system with all functions enumerated does not necessarily fit the needs of the operating area, Table IV, Countermeasures Operation Synthesis, presents a method for describing a basic operation synthesized to meet a specific operating area's needs. (The control functions were omitted from the table since they were assumed to be ever-present.) Each SLA's environmental and casualty problem was evaluated to determine the appropriate set of countermeasures. Several SLA-CM operations are evaluated in the table. One SLA action at H+1 in the survival phase is described in Figure 12, Illustrative Countermeasure Operation for SLA 354A.

A set of similar subsystem syntheses are expected to evolve from detailed analyses of all probable operations needed to alleviate the many problems expected in a nuclear attack. Analyses of these operations, including the frequency of occurrence of the resource needs, should provide a basis for measuring the effectiveness of the local CD system.

F. Component Identification and Organization

Once the appropriate functions were identified they were assigned to subsystems of the organization. Any part of the system is considered a component; thus, a subsystem and a team are both components but at different levels.

The typical organizational structure of the system is presented in Figure 13, Detroit Civil Defense Organization. Five levels of organization were identified together with the degree of participation in the control function.

A few of the teams may not have been identified since not all of the detailed plans have been prepared; however, sufficient information is available to validate the control, shelter, extra-shelter, and support subsystems.

III. DETROIT SYSTEM SYNTHESIS

A. General

The foregoing section in the detailed approach for describing operating subsystems discussed the synthesis procedure; however, it mentioned only the means for recording and displaying the description. As previously stated, system description is based on functional flow and schematic block diagrams which give a dynamic character to the resource organization and allocation matrix. These diagrams define the problem-solving operations identified with specific areas. The approach to the final aspect of system synthesis is presented in this section.

The Detroit CD system has been described by existing civil defense plans which state: the problem-solving mission of each element; the organization of its personnel,

Table IV

COUNTERMEASURES OPERATION SYNTHESIS

SLA No.	Problem* Definition	1 Provide Shelter	2 Provide Warning	3 Provide Remedial Movement of People	4 Rescue Those Trapped	5 Provide Protective Clothing	6 Maintain Health	7 Suppress Fires	8 Maintain Order	9 Shutdown for Attack	10 Disperse Survivors	11 Harden Shelters and Resources	12 Provide Aid and Medical Care	13 Provide Food and Water	14 Provide Housing	15 Inform Public of Situation	16 Restore Essential Facilities	17 Decontaminate Essential Areas	18 Provide Welfare Services
		Survival Phase Functions, H+1 to H+2																	
354A	5-B			X	X			X	X		X		X			X	X		
351B	6-C	X		X	X			X	X		X		X			X			
206	9-C	X		X	X				X		X		X			X			
456	5-A			X	X			X	X		X		X			X	X		
507	9-A	X		X	X				X		X		X			X			

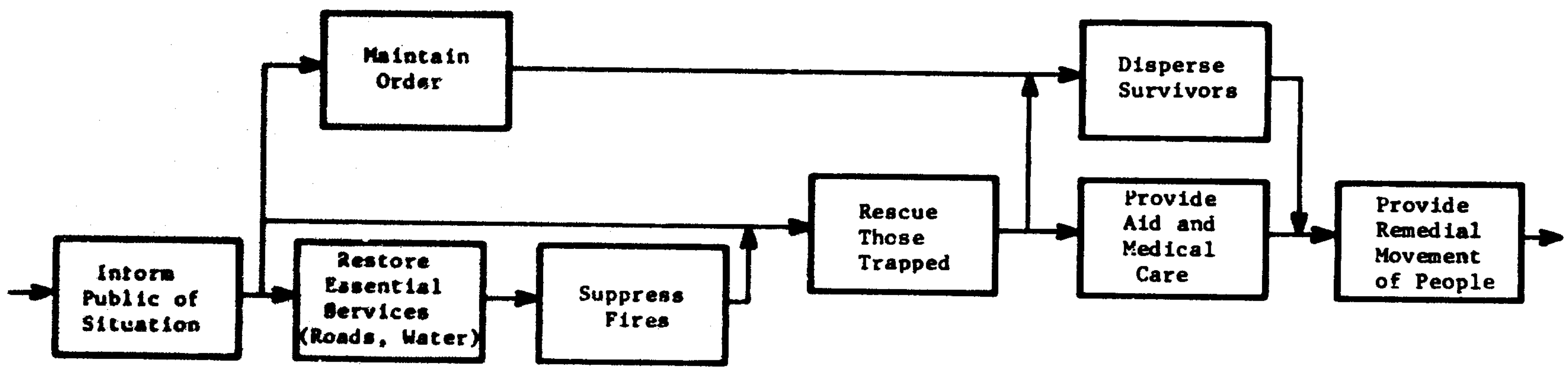
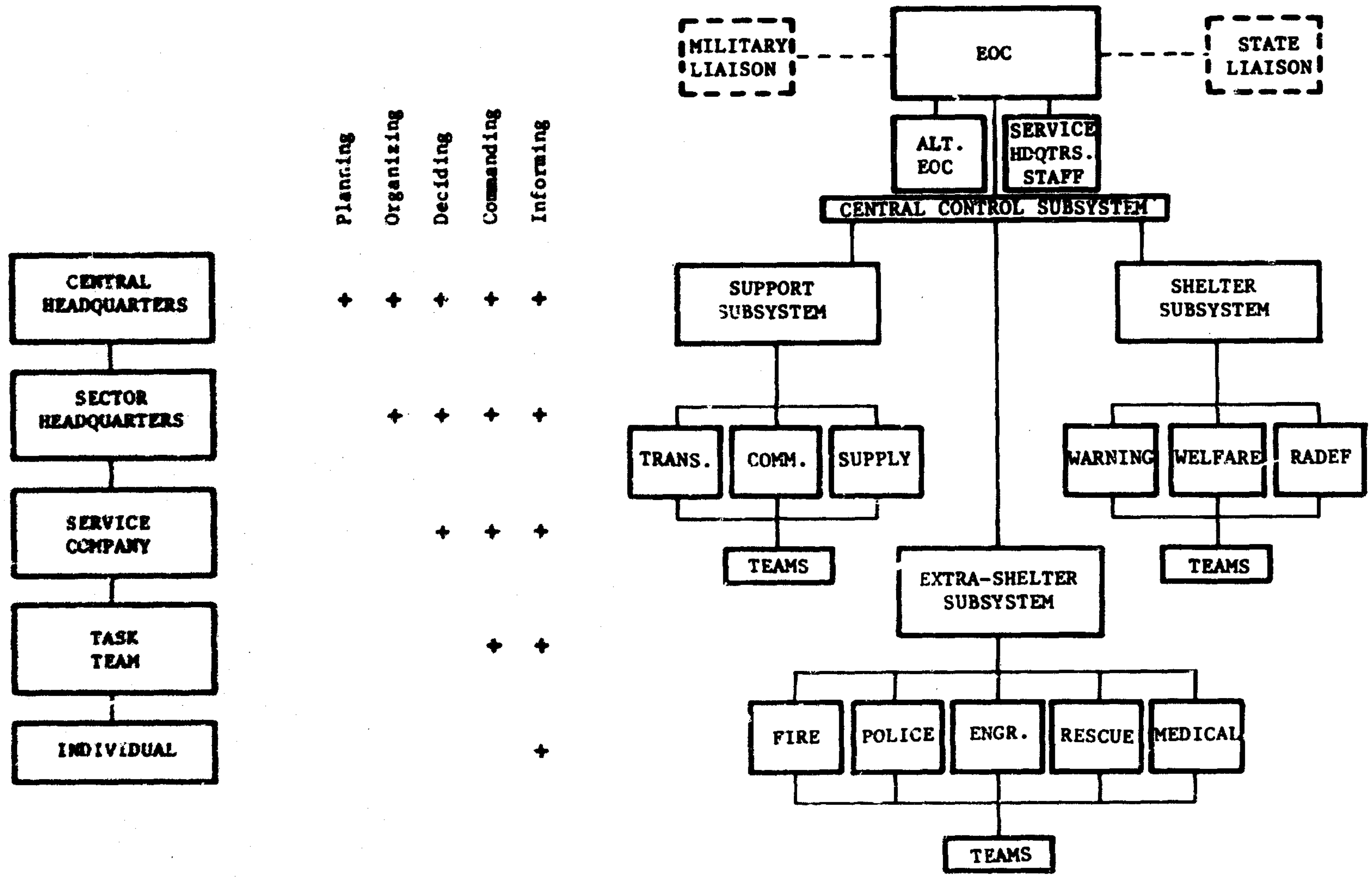


Fig. 12. Illustrative Countermeasure Operation for SLA 354A. (FFBD)



a. Elements

b. Control Functions

c. CD Organization

Fig. 13. Detroit Civil Defense Organization.

equipment, and facilities; the duties to be performed; and a description of the operational situation. However, existing plans are not complete. Moreover, these plans are voluminous and tend to obscure the sequence, time, and distance relationships that are critical to the overall description. For this reason, the adopted system description is based on concise diagrams as well as a matrix which integrates components, resources, and operations. The total system synthesis represents a summation of the basic operating subsystems.

The Detroit CD system description model is by no means detailed in depth; however, all major aspects are incorporated. The model is complete in the sense that a provision has been made for all functions, controls, and components; it is incomplete with respect to the desired level of detail. Continued effort is expected to add necessary details. In general, the model should be envisioned as a time-phased control subsystem with two types of CM functions being performed by the shelter and extra-shelter subsystems with the help of support subsystem. The following basic subsystem description has three aspects: function, resource mobilization, and schematic.

B. Functional Description

Figure 14, Time-Phased Central Control Operation (FFBD), represents the time-phased control functions which tie together all CM and support functions. In this figure, each block has (wherever possible) a number and page reference to Detroit civil defense plans; the feedback loops permit time interactions to accomodate the CM program. Overall completeness was emphasized rather than depth of detail; subsequent effort will be directed toward refinement in detail and accuracy.

Figure 15, Typical Service Control Operation (Firefighting), illustrates a deployment control operation. The Medical Care, Police, RADEF, Welfare, Engineering, and Rescue Services have been treated in a similar manner. The diagram in Figure 12 illustrates a composite of civil defense services joined in a program to counter SLA problems.

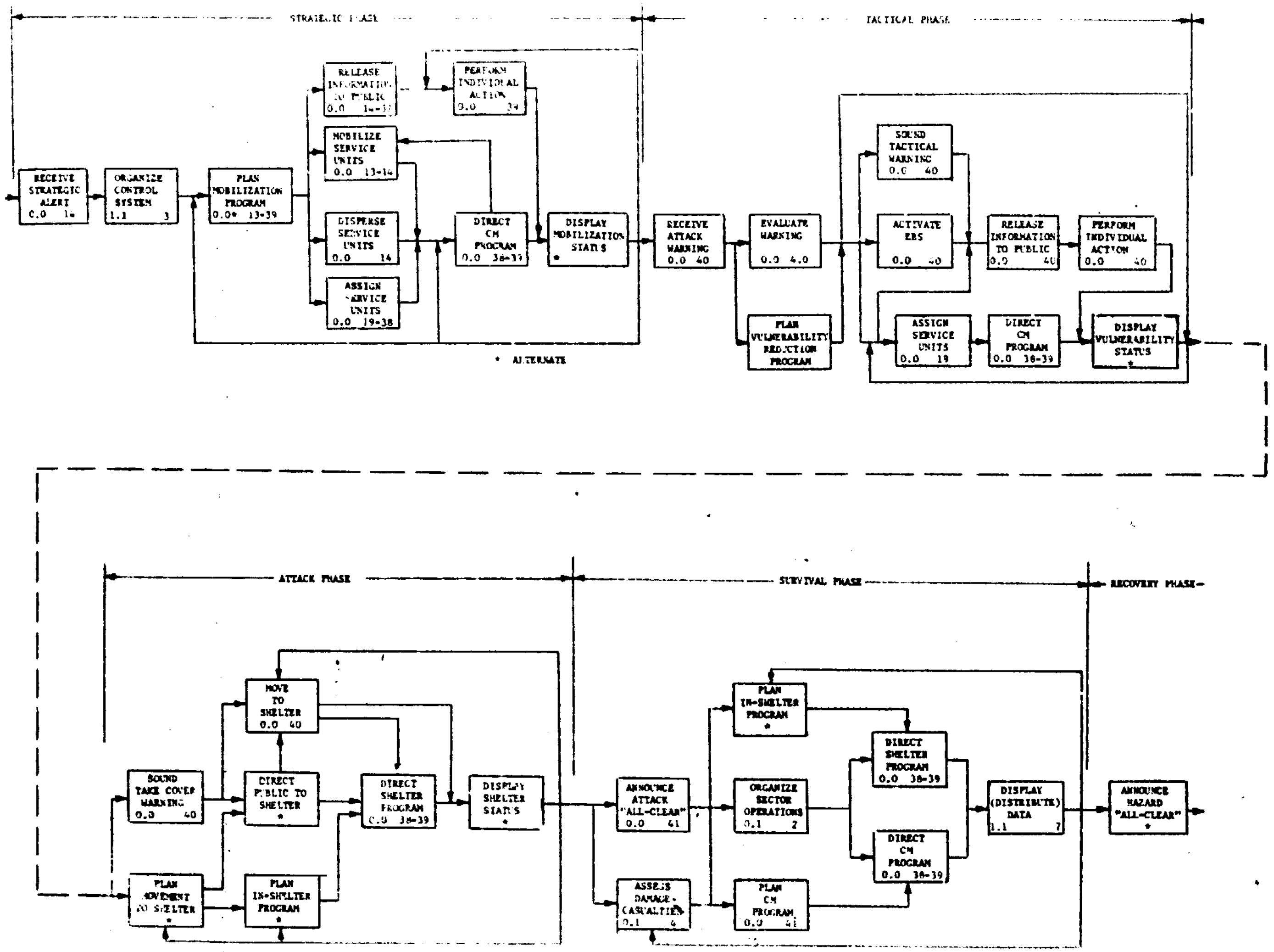
Thus, the three FFBD's (Figures 12, 14, and 15) represent the functional description of the Detroit CD system with respect to a typical SLA.

C. Resource Mobilization Description

Table V, Resource Organization Assignment Matrix, is a matrix showing the origin and allocation of resources and functional assignments to organizational components for the CM operation defining the survival phase (shown in Table IV). This concept can be expanded readily to cover all operations during all time phases.

D. Schematic Description

The subsystems are depicted in Figure 16, Basic Operating Subsystem Schematic (SBD), as units are deployed with respect to a specific operating area. These units, linked



NOTE: Numbers in blocks designate Detail Flow and page numbers for reference.

Fig. 14. Time-Phased Central Control Operations.

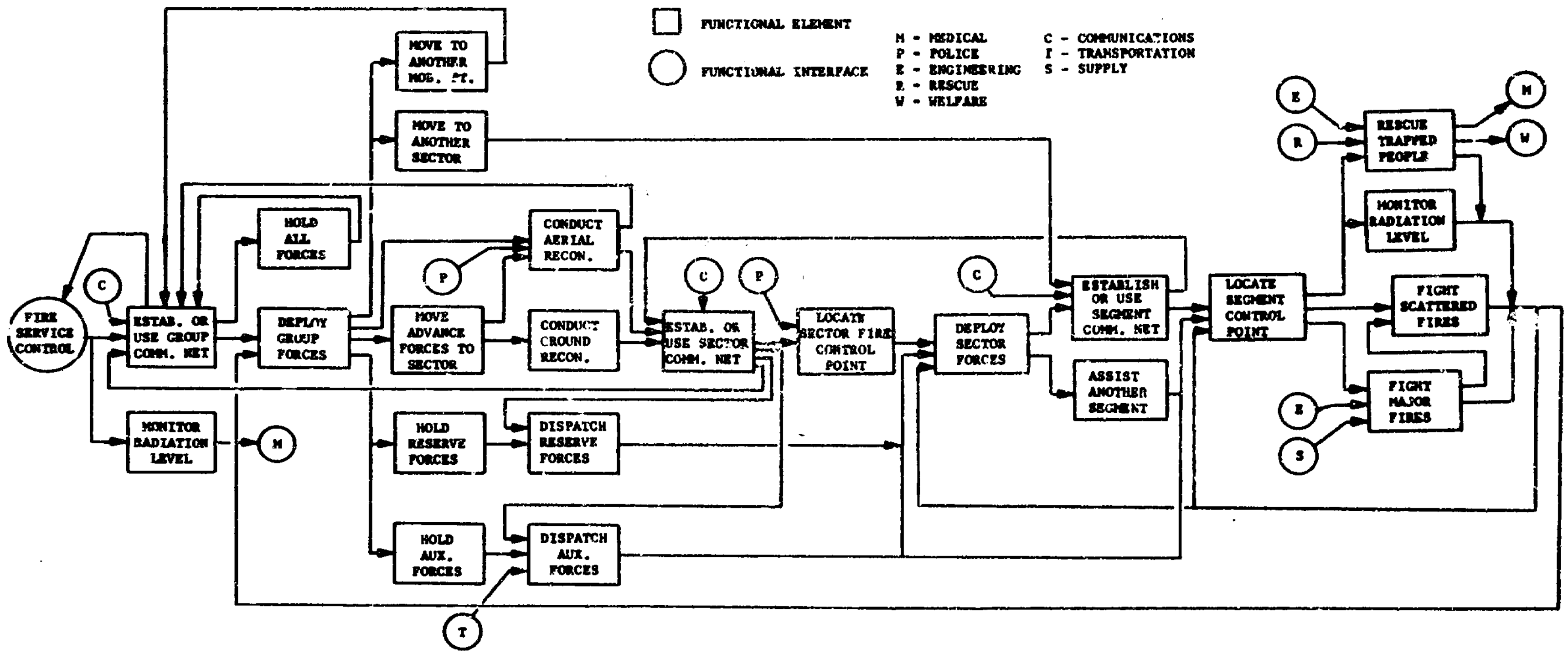


Fig. 15. Typical Service Control Operation (Firefighting)

TABLE V

RESOURCE ORGANIZATION ASSIGNMENT MATRIX

SLA 354A RESOURCES	ORGANIZATION ASSIGNMENT: HEADQUARTERS				SUPPORT				WELFARE				MEDICAL				FIRE				POLICE				ENGINEERING				RESCUE			
	Control	Support	Shelter	Mobile	Control	Support	Shelter	Mobile	Control	Support	Shelter	Mobile	Control	Support	Shelter	Mobile	Control	Support	Shelter	Mobile	Control	Support	Shelter	Mobile	Control	Support	Shelter	Mobile	Control	Support	Shelter	Mobile
<u>INTERNAL</u> (within SLA):																																
Public Elementary School											X																					
<u>EXTERNAL</u>:																																
Office of Civil Defense	X	X	X	X	X				X				X				X				X				X				X			
Dept. of Health													X	X	X	X																
Public High Schools															X																	
Hospitals															X																	
Dept. Public Works						X					X														X	X		X				X
Public Light Comm.		X				X				X	X				X								X				X	X				
Dept. of Water Supply							X				X																	X				
Fire Dept.											X					X	X			X												X
Police Dept.											X					X					X			X								
Dept. Parks & Rec.											X					X													X			X
Welfare Dept.						X			X	X	X																					
Dept. of Street R'ways.					X	X		X																								
Dept. Pub. Works, Trans.						X		X																								
Civil Serv. Comm.					X	X	X	X			X																					
Dept. Purch. & Supplies						X	X	X																								
Special City Agencies					X	X	X	X			X				X	X												X				X
American Red Cross															X	X																
Wayne Cty. Med. Society															X	X																
Detroit Edison Co.																										X	X					
Mich. Consol. Gas. Co.																										X	X					
Detroit Area Contractors																												X				
Nat'l Def. Trans. Ass'n.								X																								
Mich Bell Tel. Co.	X				X				X												X											
Amateur Radio Oper.	X				X				X				X				X				X				X				X			

FUNCTION ASSIGNMENT Countermeasures Operation;	HEADQUARTERS	SUPPORT	WELFARE	MEDICAL	FIRE	POLICE	ENGINEERING	RESCUE
	Control: Inform public of situation			Shelter: Provide aid and medical care Mobile: Provide remedial movement of people	Mobile: Suppress fires Rescue those trapped	Mobile: Maintain order Disperse survivors Inform public of situation	Mobile: Restore essential services - roads and water	Mobile: Rescue those trapped Disperse survivors Provide remedial movement of people
Control Operation:*								
Support Operation:*								

* Not defined.

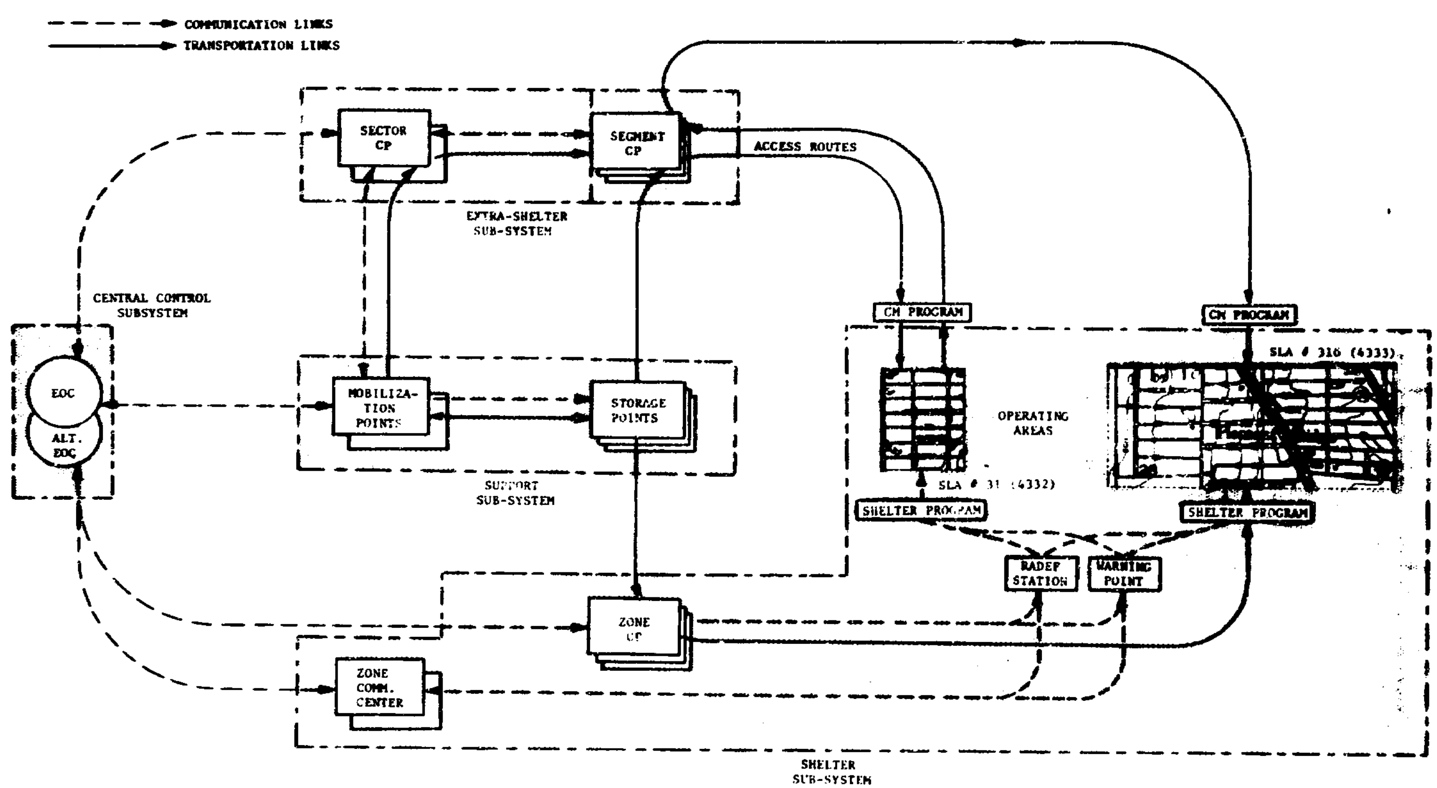


Fig. 16. Basic Operating Subsystem Schematic (SBD).

by information and transportation routes, form a network capable of sustaining CM operations at the designated SLA.

E. Total System Description

The total system is made up of many basic subsystems operating simultaneously. The CM operations may differ from area to area depending on environment, priority, and available resources. Priority is based on the expected number of survivors added by alternative operations. Figure 17, Detroit Civil Defense System Diagram, illustrates countermeasures united in a controlled operation to solve the problem in a specific SLA.

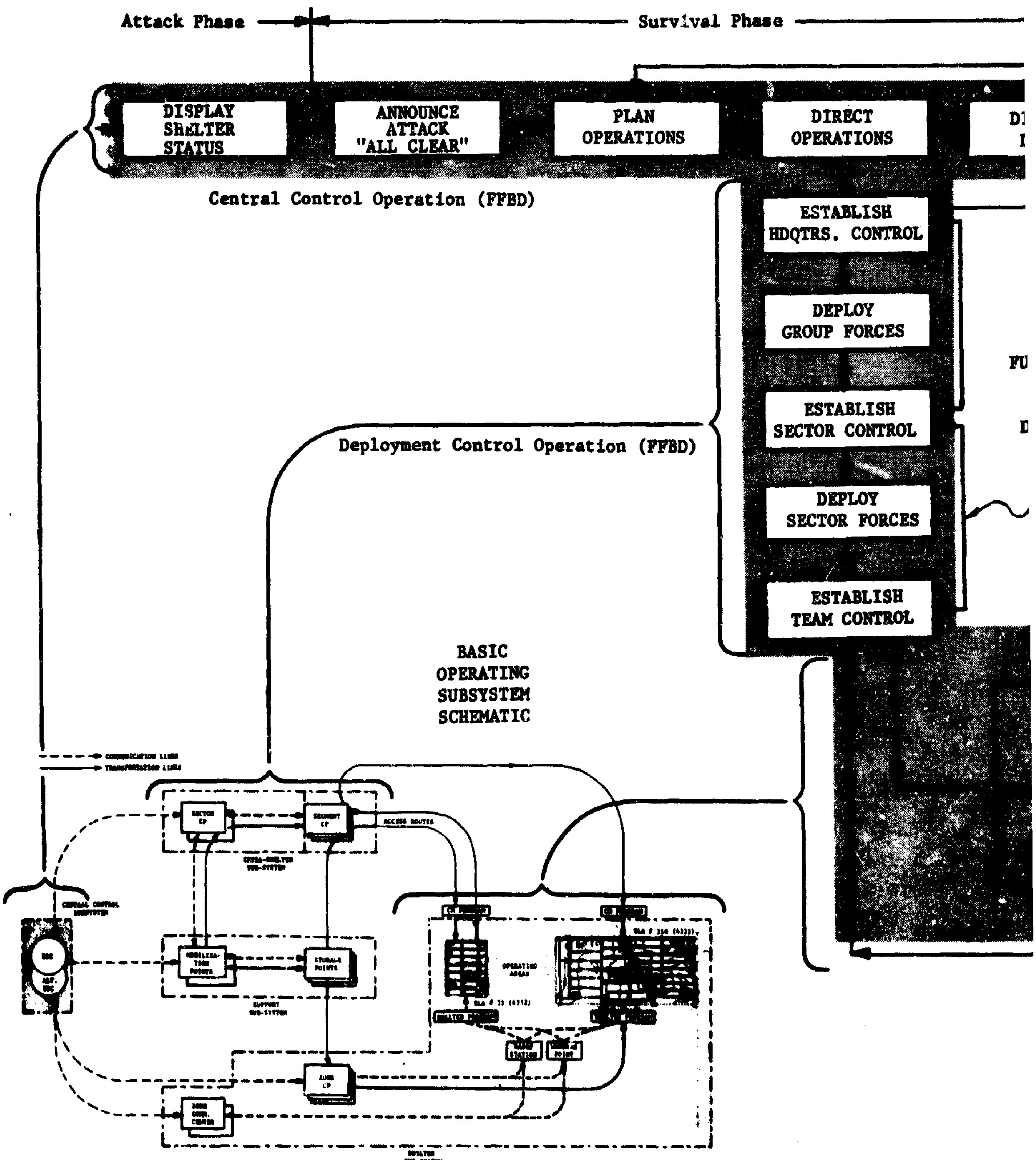
Finally, in the local Emergency Operations Center (EOC), the total system may be viewed as a set of status boards which display the state of operations in each operating area. Thus, the EOC (or its alternate) handles all SLA's; the zone (or sector) handles 10 to 50; the complex (or segment) only a few or perhaps only one. At each level, functions are assigned and resources are allocated to achieve the civil defense objectives. The schematic shows one SLA as a source and another as a recipient for survivors; such a situation would alter the civil defense program in the SLA.

IV. DISCUSSION

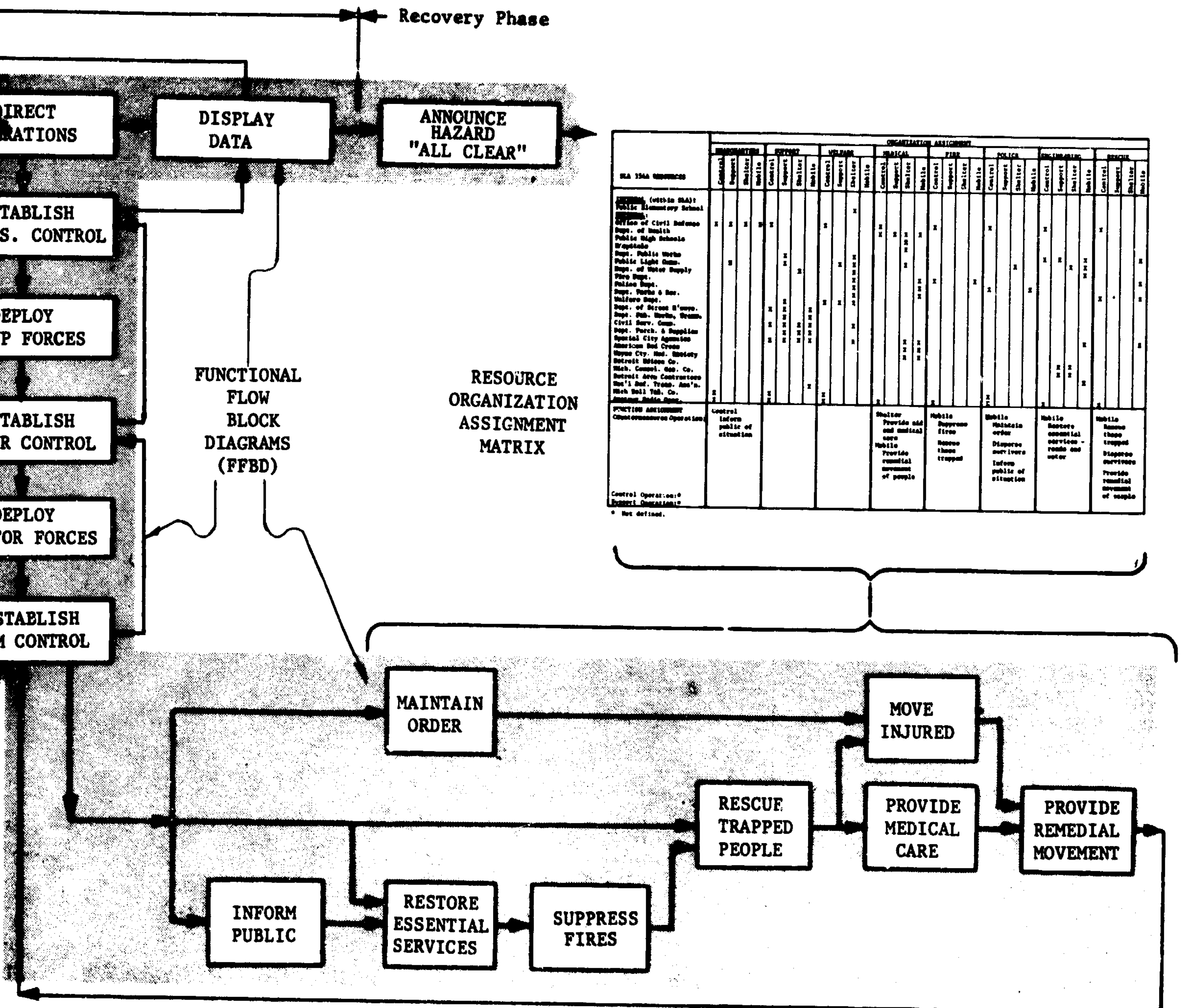
The Detroit CD system, in all its complexity, is difficult to represent in a simplified manner. Several weak points need further development before the description is thoroughly validated. For example, correlating land use with structure type appears to be a key factor in coupling problem definition with CD operations. Considerable effort is needed to develop this approach within the system concept.

As another example, unless problem definition is in equivalent terms with problem solution, the system developed to solve the problem will be unrelated to it. Thus, problem definition forms the basis for system synthesis; feedback from the synthesis is necessary to insure compatibility in problem definition. In the course of preparing the basis for system synthesis and calculating damage, several additional facts became apparent and may be considered as feedback. First, structural-type classification and weapon effects appear to be the controlling parameters for both casualty estimation and property damage calculations (See Figure 8). Second, structure-type distributions vary with land use. For example, wood frame may dominate single family residences; brick, multi-family dwellings; reinforced concrete, commercial and institutional; and steel frame, industrial. Damage calculation studies should (but do not) emphasize these two central points.

A third apparent fact is that density-of-structure by land use, as it affects depth of debris, should receive more attention. A fourth is that firespread as a function of structure type, density, and land use should be further investigated.



Attack Phase
Survival Phase
DISPLAY SHELTER STATUS
ANNOUNCE ATTACK "ALL CLEAR"
PLAN OPERATIONS
DIRECT OPERATIONS
Central Control Operation (FFBD)
ESTABLISH HDQTRS. CONTROL
DEPLOY GROUP FORCES
ESTABLISH SECTOR CONTROL
DEPLOY SECTOR FORCES
ESTABLISH TEAM CONTROL
Deployment Control Operation (FFBD)
BASIC OPERATING SUBSYSTEM SCHEMATIC



Countermeasures Control Operation (FFBD)

Fig. 17. Detroit Civil Defense System Diagram.

2

There are differences in emphasis on fire-effect parameters among investigators. Present fire-effect studies imply that the fireball remains on the ground (surface burst) until almost all thermal energy has been radiated; 80 percent of the energy from a 5-MT burst is emitted in the first 20 seconds. A rapidly rising fireball (e.g., one that rises 5 miles/minute) could present a significantly different fire picture . As another example, available casualty functions are not easily correlated with the off-set distance, overpressure, etc., of the nuclear environment.

Finally, the level of detail continues to be a major problem; some areas are thoroughly described, while others are vaguely referenced. It is tempting to follow a well-defined path to the lowest level; it is also tempting to add definition where there is none. An attempt has been made to establish a uniform level of definition across the entire system rather than to achieve greater depth; however, some service functions have been detailed to a lower level only to gain assurance that the higher level is adequate. Therefore, the current level of description represents a useful beginning for system synthesis, but continued effort can be expected to yield more detail and to develop the dynamic aspects of the system.

V. CONCLUSIONS

A beginning has been made toward a useful system description. Functions, controls, and components have been interrelated into a composite whole to describe the Detroit CD system and how it operates.

The functional flow and schematic block diagrams do offer a concise description of CD operations; however, improvement is needed in the Resource Organization Assignment Matrix (Table V). All three descriptions need development in detail.

A land-use classification scheme and the casualty functions related to building type and land use need to be developed and standardized for SLA's and need to be more closely related to the system description. Basic concepts, presented herein, form the foundation for an analytical system model for evaluating system alternatives.

Problem definition studies suggest the following needs:

1) A more refined method for assessment of depth of debris including a density-of-structure study by land use;
2) A more practical firespread model than existing statistical models;
3) A better relationship between vulnerability indices and casualty curves and a consistent set of casualty curves based on structure and land use;
4) An improved model of megaton-weapon fireball parameters including effect of rate of rise of the fireball.

VI. RECOMMENDATIONS

Results of this research task suggest the following recommendations:

1) A study of a land-use classification system that relates damage calculations to operating areas should be initiated immediately.
2) A study of density of structure should be a part of the land-use system study and should influence type classification.
3) Depth of debris criteria that recognizes both access (mobility) and entrapment problems should be developed by land use.
4) Firespread models should be developed as a function of structure type, building density, and firebreaks for typical SLA's and land uses.
5) A consistent set of casualty curves or means for generating them must be standardized.
6) Time phases suited to the system operation and evaluation scheme should be standardized.
7) All civil defense system alternatives should be described in the context of control, shelter, extra-shelter, or support operations.
8) All system operations should be defined by functional flow and schematic block diagrams.
9) Studies in system synthesis should continue to greater levels of detail and should be supported by objective selection and systems analysis studies to insure that an appropriate interface exists between problem definition and system evaluation.

Appendix A

Study Plan

Appendix A

Study Plan
(Work Unit 4113E - Description of the Detroit CD Operating System)

I. INTRODUCTION

This paper contains a work plan for the description of the Detroit civil defense operating system under Work Unit 4113E. The objective is to describe the Detroit system for incorporation in the Five-City Study and to perform the description within the civil defense system analysis matrix framework. The synthesis of alternative near-future CD operating systems will be initiated by this activity.

II. WORK PLAN

A. General

Figure 1, which is in the Introduction, is a schedule for the completion of the tasks described in Section B, below. This work plan is based upon a literature search within four categories: (1) methodology for system studies; (2) reports and hearings related to problem definition, objective selection, and system synthesis; (3) Five-City Study guidance material and reports of progress; and (4) Five-City Data Bank material on Detroit's social systems and civil defense system.

B. Description of Tasks

1. Planning and Preparation of Work Plan

This task, including the following subtasks, is completed with the acceptance of this work plan.

a) Review of OCD systems evaluation approach.
b) Development of system synthesis methodology.
c) Review of municipal civil defense components and integrators (especially Detroit).

2. Data Gathering

This task represents that effort necessary to collate data concerning the planning, system synthesis, and reporting tasks. Results of this work will be evident in the report bibliography. It will continue throughout the synthesis period.

3. Synthesize Alternate Detroit CD System

This is the major task under the contract. By a study of collated data, a Detroit CD system will be synthesized as a part of the Five-City Study. A description will be prepared of an "alternate" Detroit CD system based on an objective study of the matrix and the Detroit social system. The alternate will closely approximate the "in-place" Detroit CD system but will be functionally complete.

a) Assume and prepare problem definitions and objective selections for components and integrators of the operating system.

b) Synthesize subfunctions, subcomponents, and controls for the Detroit (alternate) system based on all available offsite data.

4. Draft Report

A draft description of the CD system for Detroit will be prepared by 1 July for technical monitor review and comment.

5. Synthesize the Detroit System

Modify the alternate CD system to fit the present CD system as planned for Detroit and as determined by onsite investigation.

a) Refine problems and objectives as necessary.

b) Redescribe the components and integrators as necessary.

A visit will be made to Detroit as soon after the technical monitor review as is practical.

6. Final Report

Prepare a final report consistent with the accepted plan; include the Detroit CD system, an alternate (objectively complete) Detroit system, and data bibliography. Deliver by 31 August 1967.

Appendix B

Land-Use Classification

Appendix B

Table B-I

LAND-USE CLASSIFICATION

				Land-Use Classification					Estimated
								Typical	Average
SLA Class	Open	R1	R2	RH	B	BH	M	C/T No.	Density
I-1	75-100	0-25			0-25		0-25	354A	1584
I-1 A	75-100		0-25	0-25	0-25	0-25			
B	75-100		0-25	0-25		0-25		17	4322
C	75-100		0-25				0-25	58	9
D	75-100	0-25		0-25		0-25		301A	2821
E	75-100		0-25	0-25	0-25		0-25	558	20209
F	75-100	0-25	0-25	0-25	0-25			788	9080
G	75-100			0-25	0-25	0-25	0-25	501	1505
II-2	50-75	0-25			0-25		0-25		
II-2 A	50-75	0-25	0-25	0-25	0-25			307A	4840
B	50-75	0-25	0-25	0-25	0-25		0-25	666A	5050
II-3	50-75	25-50			0-25			353B	4430
II-3 A	50-75	25-50		0-25	0-25			404B	6009
III-4	25-50	50-75		0-25	0-25	0-25		454	4668
III-4 A	25-50	50-75	0-25	0-25	0-25		0-25	404A	6683
B	25-50	50-75	0-25	0-25	0-25	0-25		455	4798
C	25-50	50-75	0-25		0-25				
IV-5	0-25	75-100							
IV-5 A	0-25	75-100		0-25	0-25			351B	11118
B	0-25	75-100	0-25			0-25		406	7945
IV-6		75-100	0-25						
IV-6 A	0-25	75-100	0-25		0-25			75	12268
B		75-100	0-25		0-25			76	13130
IV-7		75-100			0-25	0-25		410B	5997
IV-7 A		75-100		0-25	0-25	0-25		186	16353
B	0-25	75-100	0-25		0-25	0-25		407	9128
C		75-100			0-25			410A	8646
D		75-100	0-25		0-25	0-25		412	11734
E	0-25	75-100		0-25	0-25	0-25		414	7753
F		75-100		0-25	0-25			603B	11456
IV-8		75-100	0-25	0-25	0-25	0-25	0-25		
IV-8 A		75-100	0-25	0-25	0-25			158	19065
B		75-100		0-25		0-25		190	7432
C	0-25	75-100	0-25	0-25	0-25			203B	9598
D		75-100		0-25	0-25	0-25	0-25	204B	8105
E	0-25	75-100	0-25	0-25	0-25		0-25	207A	9028
F		75-100	0-25		0-25	0-25	0-25	253	11591
G		75-100	0-25	0-25	0-25	0-25		256B	9041
H		75-100		0-25	0-25		0-25	615A	11181
I	0-25	75-100	0-25	0-25	0-25	0-25		660	12178

Table B-I (Continued)

SLA Class	Open	Land-Use Classification R1	R2	RM	B	BH	M	Typical C/T No.	Estimated Average Density
IV-9		75-100			0-25	0-25	0-25	662	15694
IV-9 A		75-100					0-25	664	17207
IV-10		75-100	0-25		0-25		0-25	204A	8522
IV-10A	0-25	75-100			0-25		0-25	205B	9848
B	0-25	75-100	0-25		0-25		0-25	207B	7597
C		75-100			0-25		0-25	256A	11671
V-11		50-75	0-25		0-25	0-25			
V-11A		50-75	0-25			0-25		156	18223
B	0-25	50-75			25-50			357B	6527
V-12		50-75	0-25	0-25	0-25		0-25	355B	10543
V-12A		50-75	0-25	0-25	0-25	0-25		208	12285
B	0-25	50-75	0-25	0-25	0-25		0-25	210	10225
C	0-25	50-75	0-25	0-25	0-25			302C	8429
D	0-25	50-75	0-25	0-25	0-25	0-25		413	8614
E		50-75	0-25		0-25		0-25	354D	8734
VI-13		50-75			0-25		25-50	604	11696
VI-13A	0-25	50-75			0-25		25-50	206	6389
B		50-75	0-25	0-25	0-25		25-50	601B	7106
VI-14		25-50			0-25		25-50		
VI-14A	25-50	25-50			0-25		25-50	202	9357
B		25-50	25-50		0-25		25-50	561	13894
VI-15		25-50	0-25	0-25	0-25		25-50		
VI-15A	25-50	25-50	0-25	0-25	0-25		25-50	159	14700
B		25-50		0-25	0-25		25-50	205A	6135
C		25-50	0-25		0-25		25-50	355A	3149
D	25-50	25-50	0-25		0-25		25-50	615B	4484
E	0-25	25-50	0-25	0-25	0-25		25-50	661	4928
VII-16		50-75	25-50	0-25					
VII-16A		50-75	25-50	0-25	0-25	0-25		154	20634
B		50-75	0-25	25-50		0-25		181	15271
C		50-75	25-50	0-25		0-25		185	19675
D	0-25	50-75	25-50	0-25	0-25	0-25	0-25	209	15024
E	0-25	50-75	25-50	0-25	0-25			262B	11070
F		50-75	25-50		0-25			302B	14256
VII-17		25-50	25-50	0-25	0-25	0-25		161	20143
VII-17A		25-50	25-50	0-25		0-25		157	20187
B		25-50	25-50	0-25				160	26189
C	0-25	25-50	25-50	0-25	0-25			171	16670
D		25-50	0-25	25-50		0-25		183	24099
E	0-25	25-50	25-50	0-25	0-25		0-25	203A	10157
F		25-50	25-50	0-25	0-25		25-50	251	9672
G		25-50	25-50	0-25	0-25	0-25	25-50	254	8440
H	0-25	25-50	25-50		0-25		25-50	261	12195
I	0-25	25-50	25-50	0-25	0-25	0-25		608	12974
J		25-50	25-50		0-25	0-25	0-25	609	11418
K	0-25	25-50	25-50		0-25	0-25		663	20018
L		25-50	25-50		0-25			713	13020
M	0-25	25-50	25-50	0-25				751	10296
N		25-50	25-50	0-25	0-25		0-25	780	21789

Table B-I (Continued)

SLA Class	Open	R1	R2	RM	B	BH	M	Typical C/T No.	Estimated Average Density
			Land-Use Classification						
VIII-18			75-100		0-25	0-25		68	20053
VIII-18A	0-25		75-100			0-25		14	23738
B			75-100			0-25		70	20878
C			75-100		0-25			119	2167[illegible]
D	0-25	0-25	75-100		0-25			652	12096
E		0-25	75-100		0-25			653	12543
F	0-25		75-100		0-25			767	24339
G	0-25		75-100		0-25	0-25		116	19720
H	0-25	0-25	75-100		0-25	0-25		793	17895
VIII-19			75-100	0-25	0-25	0-25		523	22077
VIII-19A			75-100	0-25	0-25			15	19553
B		0-25	75-100	0-25	0-25	0-25	0-25	19	25639
C			75-100	0-25	0-25	0-25	0-25	59	17899
D			75-100	0-25	0-25		0-25	109	17147
E	0-25		75-100	0-25	0-25			122	16432
F			75-100	0-25				155	25506
G		0-25	75-100	0-25	0-25	0-25		162	26403
H	0-25		75-100	0-25	0-25	0-25		567	15514
I	0-25		75-100	0-25	0-25		0-25	781	14559
J	0-25	0-25	75-100	0-25	0-25			786	15540
K		0-25	75-100	0-25	0-25			787	13874
L			75-100	0-25		0-25		794	19795
VIII-20			75-100		0-25	0-25	0-25	73	15288
VIII-20A	0-25		75-100		0-25		0-25	13	19640
B			75-100		0-25		0-25	62	19193
C	0-25		75-100	0-25		0-25	0-25	108	13981
D	0-25		75-100		0-25	0-25	0-25	571	16824
IX-21			50-75	0-25	0-25	0-25		176D	26303
IX-21A	0-25		50-75	0-25	0-25	0-25		18	20806
B			50-75	0-25	0-25			38	23059
C		0-25	50-75	0-25	0-25	0-25		39	25791
D		0-25	50-75	0-25	0-25	0-25	0-25	176C	15958
E		0-25	50-75	0-25		0-25		180	30850
F	0-25	0-25	50-75	0-25	0-25			263	13068
G	0-25	0-25	50-75	0-25	0-25	0-25		357C	8901
H	25-50		50-75	0-25	0-25			540	19636
I		25-50	50-75	0-25	0-25	0-25		656	12613
J		25-50	50-75		0-25	0-25			
IX-22			50-75	0-25	0-25		0-25		
IX-22A	0-25		50-75	0-25	0-25		0-25	11	21480
B		25-50	50-75	0-25	0-25			172	16349
C		0-25	50-75	0-25	0-25		0-25	562	12595
IX-23			50-75		0-25	0-25	0-25	115	20846
IX-23A	25-50		50-75		0-25	0-25	0-25	117	11455
B		25-50	50-75		0-25			657	12650
X-24			50-75	25-50					
X-24A		0-25	50-75	25-50	0-25	0-25		16	21400
B		0-25	50-75	25-50	0-25			166	19464
C			50-75	25-50	0-25			511	12431

Table B-I (Continued)

	Land-Use Classification								
SLA Class	Open	R1	R2	RM	B	BH	M	Typical C/T No.	Estimated Average Density
XI-25			50-75		0-25	0-25	25-50	106	10953
XI-25A			50-75		0-25		25-50	12	26321
B			50-75	0-25	0-25		25-50	113	10698
C	0-25		50-75	0-25	0-25	0-25	25-50	114	11984
D	0-25		50-75	0-25	0-25		25-50	174	11793
E			50-75	0-25	0-25	0-25	25-50	520	16416
F	0-25		50-75		0-25		25-50	572	12786
G	0-25		50-75	0-25		0-25	25-50	756	19107
XI-26			50-75				25-50		
XI-27		0-25	25-50	0-25	0-25	0-25	25-50	42	12270
XI-27A	25-50		25-50		0-25	0-25	25-50	10	16383
B			25-50	0-25		0-25	25-50	21	14996
C		0-25	0-25	0-25	0-25	25-50	25-50	22	6121
D	0-25		25-50	0-25	0-25		25-50	26	16785
E	0-25		25-50		0-25		25-50	61	7293
F			25-50		0-25		25-50	65	14120
G	0-25		25-50	0-25		0-25	25-50	74	12846
H	0-25		25-50	0-25	0-25	0-25	25-50	101	12057
I			25-50			0-25	25-50	104	13231
J	0-25		25-50		0-25	0-25	25-50	105	7605
K	0-25	0-25	25-50	0-25	0-25		0-25	170	10876
L		0-25	25-50		0-25	0-25	25-50	211	9994
M			25-50	25-50	0-25	0-25	25-50	504	11255
N	25-50			0-25	0-25		25-50	538	18979
O			25-50	0-25	0-25	0-25	25-50	548	15805
P	25-50		0-25	0-25	0-25		25-50	556	24595
Q	25-50		25-50		0-25		25-50	566	13822
R	25-50		25-50	0-25	0-25		25-50	570	18172
S	25-50	0-25	0-25		0-25	0-25	25-50	611	4492
T	25-50	0-25	0-25	25-50	0-25	0-25	25-50	757	15399
XII-28			25-50	25-50	0-25	25-50			
XII-28A	0-25		25-50	25-50	0-25			7	17191
B	0-25		25-50	25-50	0-25	25-50		25	9470
C			25-50	25-50	0-25	0-25		27	20847
D	0-25		25-50	25-50		25-50		29	28879
E	0-25		25-50	25-50	0-25	25-50	0-25	37	15007
F		0-25	25-50	25-50	0-25	0-25		40	21481
G			25-50	25-50	0-25		0-25	43	20761
H	25-50		25-50	25-50	0-25	0-25		67	18809
I	0-25		25-50	25-50	25-50			175	17722
J	0-25		25-50	25-50	0-25	0-25	0-25	212	12947
K	25-50		25-50	25-50	0-25	0-25	0-25	510	19648
L		0-25	25-50	25-50	0-25			759	29896
XII-29			0-25	25-50	0-25	25-50			
XII-29A	0-25			25-50		25-50		24	7718
B				25-50	0-25	25-50	0-25	34	19111
C	0-25	0-25	0-25	25-50	25-50	25-50	0-25	35	15053
D		0-25	0-25	25-50	0-25	0-25	0-25	169	15783

Table B-I (Continued)

SLA Class	Open	R1	R2	RM	B	BH	M	Typical C/T No.	Estimated Average Density
				Land-Use Classification					
E	0-25	0-25	0-25	25-50	0-25	0-25		182	16441
F				25-50		0-25	25-50	505	6573
G				0-25		25-50	25-50	506	2833
H				25-50		25-50	0-25	528	10150
I				25-50	0-25		25-50	541	23469
XII-30	0-25			75-100	0-25	0-25	0-25	28	51252
XII-30A	0-25	0-25	0-25	75-100		0-25		152	22196
B			0-25	75-100		0-25		165	17500
C		0-25		75-100	0-25	0-25		189	20996
D				75-100	0-25	0-25		509	3487
E				75-100	0-25			534	22117
F	0-25			75-100	0-25				
XII-31		0-25	0-25	50-75	0-25	0-25	0-25		
XII-31A	0-25		0-25	50-75	0-25	25-50		30	38355
B				50-75	0-25	25-50		151	15504
C		0-25	0-25	50-75	0-25	0-25		153	32887
D		0-25	25-50	50-75		0-25		184	30487
E	25-50		0-25	50-75		0-25		187	51353
F	0-25	0-25	25-50	50-75	0-25	0-25		188	21082
G	0-25	0-25	0-25	50-75	0-25		25-50	213	16081
H		0-25		50-75	0-25	0-25	0-25	357A	14517
I			0-25	50-75	0-25		25-50	539	23551
J	0-25			50-75	0-25	0-25	25-50	543	18017
K		25-50	0-25	50-75	0-25	0-25		553	17859
L	25-50	0-25	0-25	50-75	0-25	0-25		758	10098
XIII-32			0-25	0-25	0-50	50-100			
XIII-32A						75-100	0-25	1	4257
B				0-25		75-100		31	25402
C				50-75		50-75		32	34910
D	0-25				0-25	75-100		33	12935
E	0-25			0-25	0-25	50-75	0-25	508	8755
F						100		530	3984
XIV-33		25-50			0-25		50-75	402A	3485
XIV-33A		25-50	0-25		0-25	0-25	50-75	57B	6325
B			0-25		0-25		50-75	554	15245
C		25-50	0-25		0-25		50-75	601A	4293
D	0-25	25-50			0-25		50-75	622	4168
E	0-25	25-50	0-25	0-25	0-25		50-75	667A	3600
XIV-34			25-50	0-25		0-25	50-75		
XIV-34A			0-25		0-25	0-25	50-75	4	5866
B			0-25	0-25	0-25		50-75	5	11331
C			0-25			0-25	50-75	20	4771
D			25-50		0-25		50-75	54	7879
E	0-25		25-50		0-25		50-75	55	7287
F			0-25	0-25	0-25	0-25	50-75	66	10559
G		0-25	25-50			0-25	50-75	255	5630
H			25-50	0-25	0-25	0-25	50-75	503	10522
I						25-50	50-75	527	5366

Table B-I (Continued)

SLA Class	Open	R1	R2	RM	B	BH	M	Typical C/T No.	Estimated Average Density
				Land-Use Classification					
J	0-25			0-25	0-25	0-25	50-75	546	6739
K	0-25	0-25	25-50	0-25	0-25		50-75	565	2539
L			25-50	0-25	0-25		50-75	519	15804
M			25-50		0-25	0-25	50-75	774	14371
XV-35		0-25	0-25	0-25	0-25	0-25	75-100		
XV-35A				0-25	0-25	0-25	75-100	2	4461
B			0-25	0-25	0-25	0-25	75-100	3	5862
C	0-25		0-25	0-25	0-25		75-100	6	3708
D	0-25		0-25	0-25		0-25	75-100	23	1486
E							100	51	5773
F	0-25		0-25	0-25			75-100	52	6459
G	0-25		0-25				75-100	53	5835
H			0-25	0-25	0-25		75-100	63	3037
I			0-25	0-25		0-25	75-100	502	5118
J			0-25		0-25		75-100	517	12511
K	0-25			0-25			75-100	547	3844
L			0-25	0-25			75-100	555	15739
M	0-25		0-25			0-25	75-100	655	6943
N	0-25	0-25	0-25			0-25	75-100	755	8876
O			0-25		0-25	0-25	75-100	789	4274

Appendix C

Problem Definition Criteria

Appendix C

Problem Definition Criteria

The net damage of each SLA class is calculated by averaging the nuclear effects for structures over the distribution of structure types characterizing each class.

The calculation is conveniently made as a vector-matrix multiplication.

$$[S_{16}] \quad \times \quad \begin{bmatrix} R_{11} & \cdots & R_{1j} \\ \cdot & & \\ \cdot & & \\ \cdot & & \\ R_{61} & \cdots & R_{6j} \end{bmatrix} \quad = \quad [X_{1j}]$$

where $[S_{16}]$ is a vector denoting the fractions of structure types in a given SLA class (C-II).

$$\begin{bmatrix} R_{11} & & \\ & & \\ & & \\ & & R_{6j} \end{bmatrix}$$ is a response matrix for the homogenous structure types for j nuclear environments.

$[X_{1j}]$ is a vector representing the net nuclear response for each SLA class. Five SLA classes were treated in this manner for blast, debris, and fire. The results are tabulated in Table C-I. Structural distributions by land use are listed in Table C-II. Structure damage as a function of nuclear weapon fire, debris, and blast effects are presented in Tables C-III, C-IV, and C-V.

This cursory analysis was made to indicate that descriptive data adopted for civil defense system synthesis can be used for damage calculations. It shows the relationship between the problem definition of city damage and the development of the countermeasure program for the survival phase. The results of the analysis are included as an example and are not intended to be a complete problem solution.

Table C-I

RESPONSE OF STRUCTURES TO NUCLEAR DETONATION (5-MT SURFACE)

SLA Class	Damage Criteria*	Distance from Ground Zero (Miles) 1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	Blast, Severe (S)	100	100	100	80	48	28	8	4	0	0	0	0	0	0
	Light (L)	100	100	100	100	88	58	40	20	8	8	8	8	0	0
	Debris	100	100	100	85	50	40	10	1	0	0	0	0	0	0
	Ignition	.1	.1	.1	.1	.1	.1	.1	.1	.098	.08	.06	.04	.013	.003
IV	Blast, S	100	92	90	82	65	33	15	0	0	0	0	0	0	0
	L	100	92	92	92	85	70	52	30	15	8	0	0	0	0
	Debris	100	91	85	79	36	24	14	4	2	0	0	0	0	0
	Ignition	.198	.198	.198	.198	.198	.198	.198	.198	.197	.191	.160	.133	.046	0
VI	Blast, S	100	100	86	74	47	15	7	0	0	0	0	0	0	0
	L	100	100	92	89	71	47	30	15	0	0	0	0	0	0
	Debris	100	92	81	67	54	5	0	0	0	0	0	0	0	0
	Ignition	.276	.276	.276	.276	.276	.276	.276	.276	.276	.24	.24	.144	.044	.044
XIII	Blast, S	100	100	68	48	32	10	5	0	0	0	0	0	0	0
	L	100	100	100	68	48	32	20	10	5	0	0	0	0	0
	Debris	100	100	79	67	55	24	12	8	4	0	0	0	0	0
	Ignition	.239	.239	.239	.239	.239	.239	.239	.239	.233	.194	.194	.100	.044	.022
XV	Blast, S	100	100	59	30	16	9	5	0	0	0	0	0	0	0
	L	100	100	78	59	30	16	12	9	6	3	0	0	0	0
	Debris	100	69	65	48	28	11	8	5	0	0	0	0	0	0
	Ignition	.735	.735	.735	.735	.735	.735	.735	.735	.733	.68	.68	.425	.068	.013
	Expected Damage: %														
	Comm. (Mod.)	1.00	.98	.80	.30	.04	.01	0							
	Bridges (Sev.)	1.00	.80	.13	.07	0	0	0							
	Vehicles (Sev.)	1.00	.97	.67	.14	.01	0	0							
	Water and Gas Lines	Sev.	Moderate		Light										
	Tel. Poles	Moderate													
	Minimum entry time # to get <100R dose for 1 hr. stay time	--	--	24	22	20	19	17	15	12	12	9	9	6	4

* Blast and debris expressed as the percent of the structures damaged; ignition as the probability of fires started.

% Probability or degree of stated damage.

\# Time in minutes.

Table C-II

PERCENT STRUCTURAL DISTRIBUTION BY LAND-USE CLASS

SLA Class	LAND-USE CLASS						
	Open	Single Family	Two Family	Multiple Family	Small Business	High Business	Manufacturing
I	75	8	--	--	8	--	8
II	50	25	--	--	13	--	12
III	25	50	--	6	6	6	6
IV	4	75	4	4	4	4	4
V	--	50	10	10	10	10	10
VI	--	25	8	8	8	--	25
VII	--	25	25	17	17	17	--
VIII	--	--	75	6	6	6	6
IX	--	--	50	12	12	12	12
X	--	--	62	38	--	--	--
XI	--	--	25	16	16	17	25
XII	--	--	32	25	17	25	--
XIII	--	--	--	25	25	50	--
XIV	--	14	14	7	7	7	50
XV	--	5	5	5	5	5	75

Source: Developed from Table I.

Table C-III

PROBABILITY OF SIGNIFICANT STRUCTURAL FIRE (5-MT SURFACE)

	Distance from ground zero (miles)							
	>22	22	16	13	12	10	9	8
	Thermal exposure (CAL/cm^2)							
LAND USE	-	5	10	15	20	25	30	40
Single family residential, R_1	0	0	.02	.05	.14	.20	.21	.21
Two family residential, R_2	0	.02	.05	.07	.12	.15	.16	.16
Multifamily residential, R_m	0	0	.05	.12	.26	.37	.39	.39
Small business, B	0	0	0	.07	.30	.47	.54	.56
High business, BH	0	0	0	.03	.25	.50	.53	.54
Manufacturing, M	0	0	0	.01	.025	.03	.03	.03

Source: "Evaluation of Nuclear Wer on Thermal Threat," SRI.

"Nuclear War and the Urban Fire Problem," Dikewood Corporation.

Table C-IV

PERCENT OF STRUCTURES DAMAGED (DEBRIS) - (5-MT SURFACE)

LAND USE	Distance from ground zero (miles) 9.5	8.0	6.0	5.2	4.7	4.2	3.7	3.2	2.7	[illegible]	2.0
	Overpressure (PSI) 1.5	2.0	3.0	4.0	5.0	6.0	8.0	10.0	15.0	[illegible]	25.0
Single family residential, R_1	0	0	1.5	15	40	44	70.5	98	98	[illegible]	98
Two family residential, R_2	0	0	1.5	15	39	44	69	98	98	[illegible]	98
Multifamily residential, R_m	0	0	1	8	23	26	51	78	85	[illegible]	97
Small business, B	0	23	50	52	56	57	60	74	76	[illegible]	100
High business, BH	0	9	22	22	23	26	44	65	80	[illegible]	97
Manufacturing, M	0	14	31	31	32	33	45	59	82	[illegible]	97

Source: "Formation of Debris from Buildings and Their Contents by Blast [illegible] Fire Effects of Nuclear Weapons," URS Corporation.

"Structural Debris Caused by Nuclear Blast," URS Corporation

Table C-V

PERCENT OF STRUCTURES DAMAGED (BLAST) - (5-MT SURFACE)

	PV CATEGORY				
	A	B	C	D	E
	PSI				
LAND USE	1.1-2	2.1-3	3.1-5	5.1-7	7.1-10
Single family residential, R_1	38	50	10	--	--
Two family residential, R_2	36	26	26	10	--
Multifamily residential, R_m	21	13	30	5	29
Small business, B	--	12	78	5	5
High business, BH	--	2	33	44	18
Manufacturing, M	--	19	27	30	21

Appendix D

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Preliminary Report.
Robert N. Hendry. January 1968. (UNCLASSIFIED)

The technical approach to the description of the Detroit Civil Defense Operating System is described in this volume; a preliminary system description is presented in the first volume.

The Detroit Civil Defense Operating System is an example of a local system synthesized as a basis for a systems analysis. A diagrammatic description, adopted in support of a narrative description to show the system's functional and physical aspects, can be developed in greater levels of detail as more information is developed.

The primary tasks in developing the diagrams were to identify and classify the controls, functions, and components and to interrelate them to show the operation of the total system. First, the elements were identified and classified by time phases within the emergency period. Second, functions and components were reassembled into a time-phased set of operations to solve civil defense problems occurring in small areas of the city.

The system description takes the form of: (1) a set of time-phased functional flow block diagrams representing functions needed to minimize or solve defined problems, (2) a resource organization assignment matrix needed to assign functions to the various system components, and (3) a schematic block diagram showing the utilization of resources needed to solve the problems occurring in the individual operating areas. The system diagram developed during the study shows all three forms of the description and represents a basic civil defense operating subsystem. The total system should be visualized as many basic subsystems operating simultaneously.

CIVIL DEFENSE SYSTEMS, SYSTEMS SYNTHESIS, SYSTEMS ANALYSIS, COMPONENTS, MISSIONS, OPERATIONS, DIAGRAMS

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Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Research Triangle Institute Post Office Box 12194 Research Triangle Park, North Carolina 27709	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

Detroit Civil Defense Operating System Synthesis, Volume II

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Preliminary Report

5. AUTHOR(S) (Last name, first name, initial)

Hendry, Robert N.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
January 1968		8

8a. CONTRACT OR GRANT NO. OCD-PS-64-56 b. PROJECT NO. Work Unit 4113E c. Systems Evaluation Division d. OCD Research Directorate	9a. ORIGINATOR'S REPORT NUMBER(S) R-OU-230-2 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
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